

ARIZONA WATER ATLAS

VOLUME 2

EASTERN PLATEAU PLANNING AREA



Arizona Department of Water Resources

DRAFT

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ARIZONA WATER ATLAS

VOLUME 2

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ARIZONA WATER ATLAS

PREFACE

Volume 2, the Eastern Plateau Planning Area, is the second in a series of nine volumes that comprise the Arizona Water Atlas. The primary objectives in assembling the Atlas are to present an overview of water supply and demand conditions in Arizona, to provide water resource information for planning and resource development purposes and help to identify the needs of communities.

The Atlas divides Arizona into seven planning areas (Figure 2-1). There is a separate Atlas volume for each planning area, an introductory volume composed of background information, and an executive summary volume. “Planning areas” are an organizational concept that provide for a regional perspective on supply, demand and water resource issues. A complete discussion of Atlas organization, purpose and scope is found in Volume 1.

There are additional, more detailed data available to those presented in this volume. They may be obtained by contacting the Arizona Department of Water Resources’ Statewide Conservation and Strategic Planning Division.

SECTION 2.0 Overview of the Eastern Plateau Planning Area

The Eastern Plateau Planning Area is unique in that it is composed of one groundwater basin, the Little Colorado River Plateau Basin. The planning area is relatively high in elevation and is geographically diverse with the highest peaks in the state as well as deep sandstone canyons and large mesas. Parts of three counties are contained within the Eastern Plateau Planning Area: Apache, Coconino and Navajo counties. Flagstaff is the largest metropolitan area and is growing rapidly, as are a number of communities in the White Mountains and on the Navajo Reservation. The planning area has a large industrial water use sector due to several electrical generating stations, large coal mining operations and a paper mill. Agricultural irrigation is relatively small-scale in terms of acreage but is a large water use sector. The Joseph City Irrigation Non-expansion Area (INA), an area designated as having insufficient groundwater to provide a reasonably safe supply for irrigation, is located in the Planning Area. Two-thirds of the land area is under tribal ownership. For this reason, tribal water resource and other characteristics are discussed separately in a number of cases in this volume. Major cities and towns, counties and the boundaries of the INA are shown on Figure 2-2.

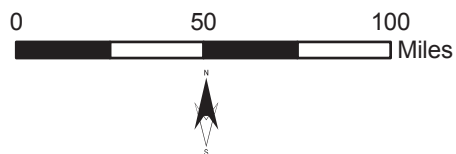
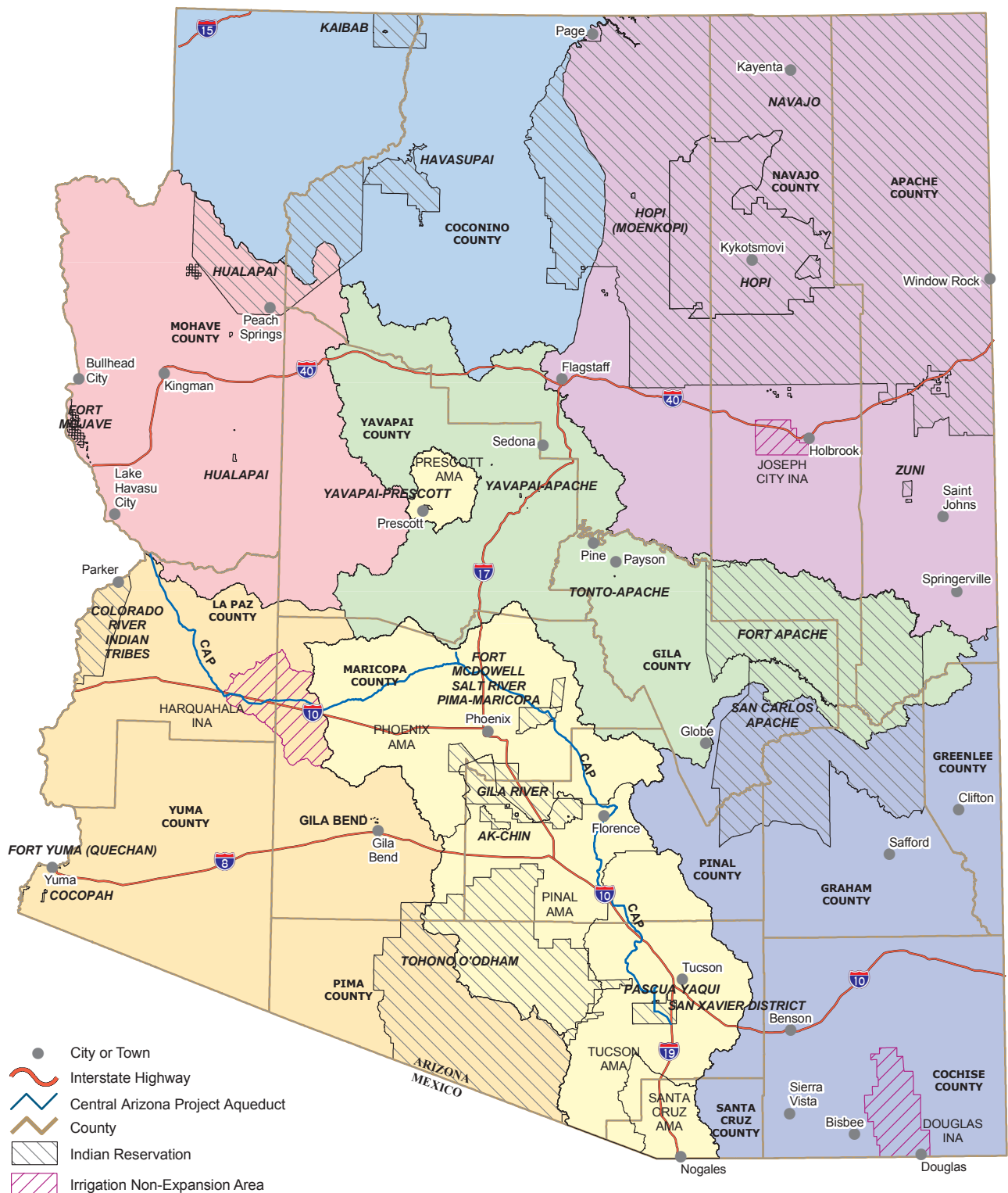


Figure 2-1
Arizona Planning Areas

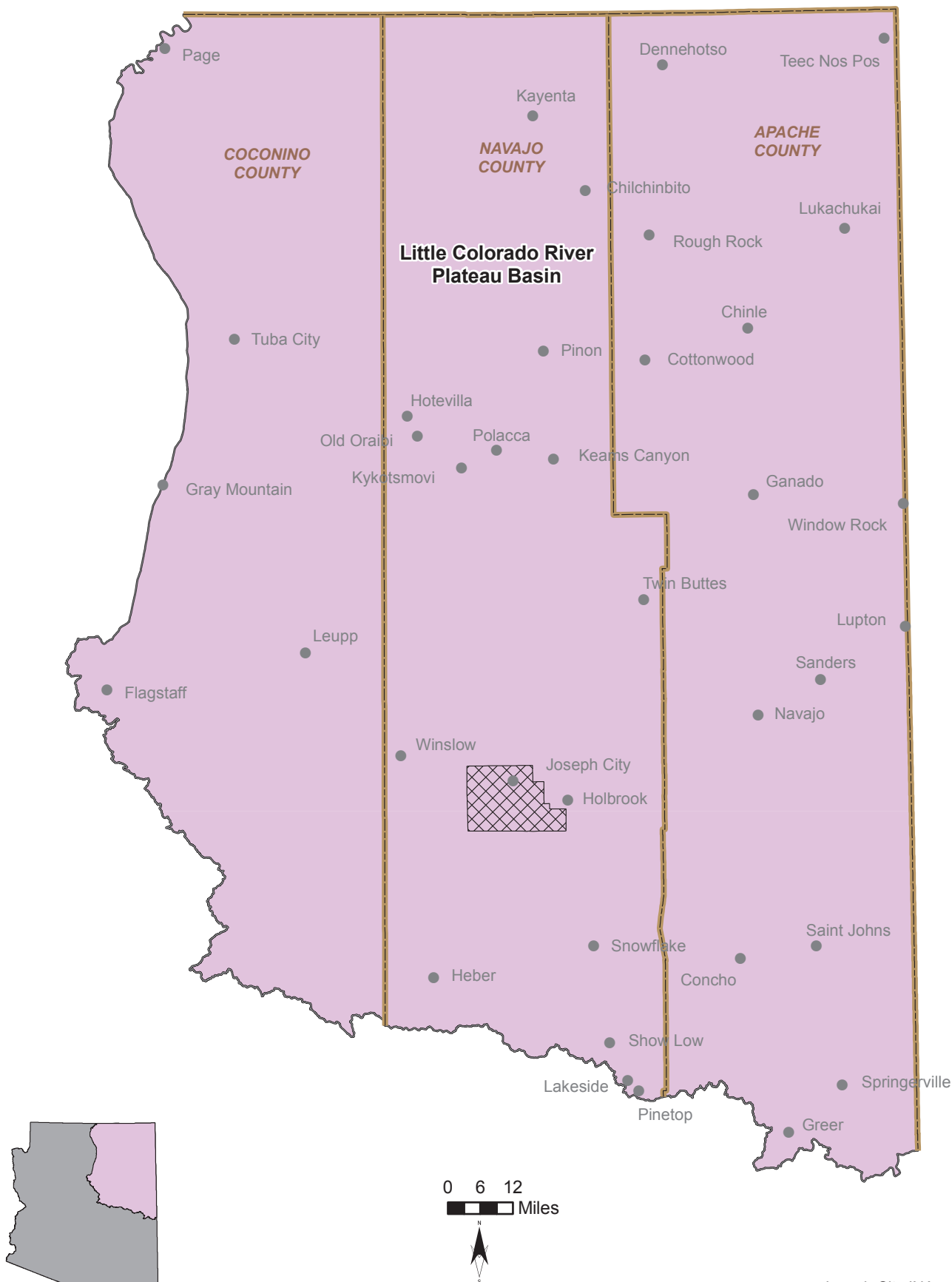


Figure 2-2
Eastern Plateau Planning Area

2.0.1. Geography¹

The Eastern Plateau Planning Area includes the northeastern corner of the state and is within the Plateau Uplands physiographic province. This province covers the northern 2/5 of Arizona and is characterized by mostly level, horizontally stratified sedimentary rocks that have been eroded into canyons and plateaus, and by some high mountains. Major mountain ranges are the San Francisco Peaks near Flagstaff, the White Mountains in the southeastern portion of the planning area and the Chuska and Lukachukai mountains located along the Arizona-New Mexico border. The Chuskas reach an elevation of almost 10,000 feet. Much of the rain and snow that falls in the Chuskas drains westward into Canyon de Chelly. The Hopi reservation is characterized by three mesas that rise to an elevation of 7,200 feet. Elevations vary from over 12,600 feet at Humphreys Peak near Flagstaff, the state's highest point, to 4,200 feet at Cameron, about ten miles north of Gray Mountain. The average elevation of the planning area is 6,061 feet.

The planning area is about 26,700 square miles and is bounded on the south by the Mogollon Rim, on the north by the Arizona-Utah border, on the east by the Arizona-New Mexico border and on the west by the Coconino Plateau Basin and Paria Basin, whose boundaries coincide closely with U.S. Highway 89 (Figure 2-1). The Mogollon Rim is an escarpment almost 2,000 feet high in some places, extending from central Arizona to the Mogollon Mountains in New Mexico. It forms a hydrologic boundary between the Eastern Plateau Planning Area and the basins of the Central Highlands and Southeastern Arizona Planning Areas.

The Little Colorado River is the main drainage for the basin, flowing from the White Mountains area and leaving the basin near Cameron. The northern third of the Eastern Plateau Planning Area/Little Colorado River Plateau Basin drains northward toward the San Juan River as part of the Colorado River watershed. In this area, Chinle Creek collects the majority of the surface water runoff. The southern two-thirds of the basin are within the Little Colorado River watershed. Streams and runoff in this area generally flow toward the Little Colorado River.

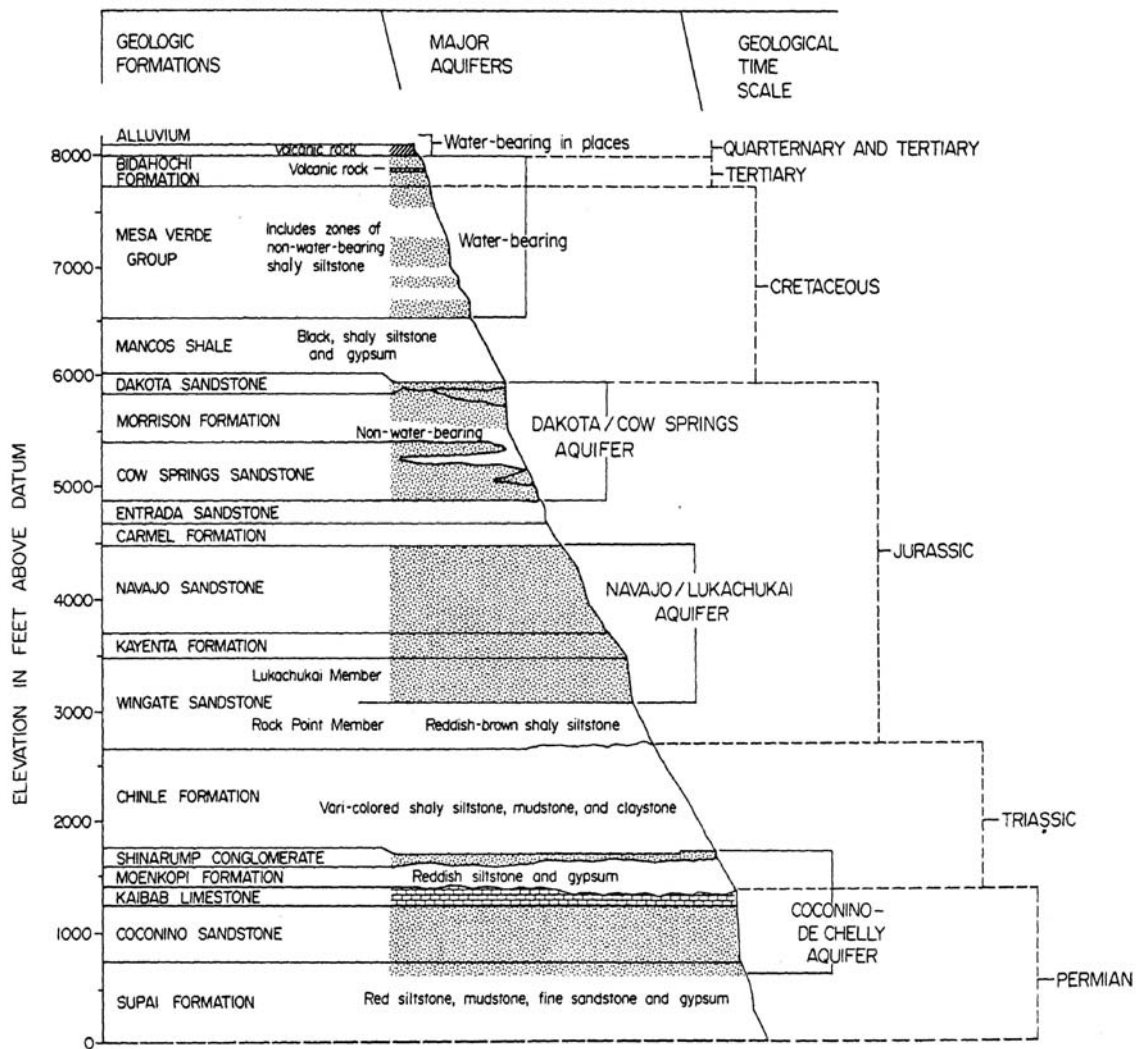
2.0.2 Hydrogeology²

There are several local aquifers and 3 regional aquifers in the Eastern Plateau Planning Area that contain large amounts of groundwater in storage. (See Figure 2-19 for the location of large local and regional aquifers). These sedimentary formations of sandstone and limestone are stacked on top of one another and are generally separated by impermeable shales and siltstones. In descending order, the regional aquifers are the D-, N-, and C-aquifers. Each has a very large areal extent within the basin and except for the D and N aquifers, there is little vertical hydrologic connection between them. These water-bearing formations gain thickness towards the center of the basin resulting in artesian conditions. Main recharge areas are along the southern and eastern periphery of the planning area. It is estimated that there are about 508 million acre-feet (maf) in storage in Little Colorado River Plateau aquifers (ADWR, 1990). Figure 2-3 shows a generalized cross-section of the water bearing formations of the planning area.

¹ Much of the information in this section is taken from the Arizona Water Resources Assessment, Volume 1, ADWR August, 1994.

² *ibid*

Figure 2-3 Water Bearing Formations of the Little Colorado River Plateau Basin



The C-aquifer is the largest and most productive aquifer in the planning area with an areal extent of 21,655 square miles. It is named for its primary water-bearing unit, the Coconino Sandstone. It is utilized as a supply south of the Little Colorado River and along the eastern edge of the basin by Flagstaff, Heber, Overgaard, Show Low, Snowflake and Concho. North of the river the C-aquifer is too deep to be economically useful or is unsuitable for most uses because of high concentrations of total dissolved solids. The Department estimated that 413 maf are stored in the aquifer (ADWR, 1989).

The N-aquifer occurs north of the Little Colorado River and has an areal extent of 6,250 square miles. Storage estimates vary from 166 maf to 293 maf (ADWR, 1989 and USGS, 1996). Navajo Sandstone and Wingate Sandstone are the main water-bearing units in the aquifer. It is generally unconfined but there are artesian conditions in the Black Mesa area and near Window Rock. This aquifer is utilized for the Black Mesa Coal Mine slurry pipeline. N-aquifer water quality is good and is a source of supply for the Navajo and Hopi reservations.

The D-aquifer is the smallest in areal extent, occurring over about 3,125 square miles. It is estimated that there are 15 maf in storage (ADWR, 1989). The D-aquifer is composed of the Dakota, Cow Springs and Entrada sandstones. There is some connection to the underlying N-aquifer. Water quality is marginal to unsuitable for domestic use due to high concentrations of dissolved solids. Nevertheless, it is utilized in the north-central parts of the planning area for domestic use.

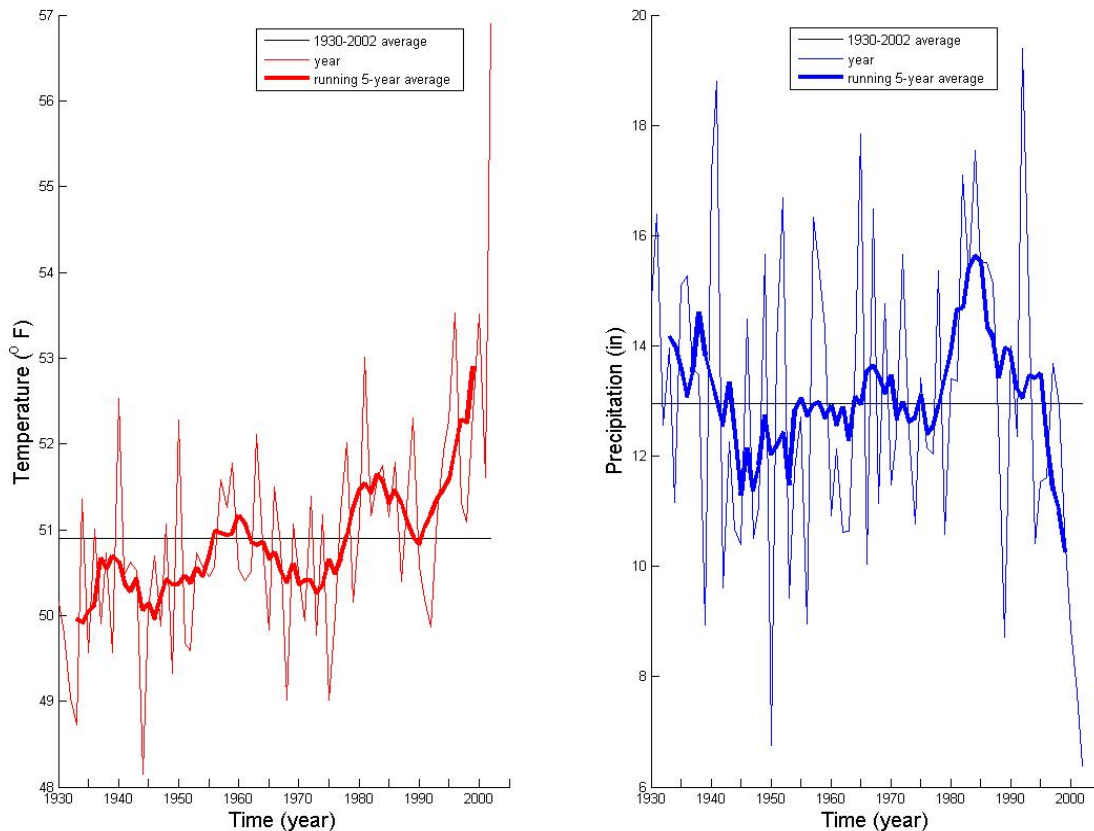
Local aquifers are important for domestic uses where the regional aquifers are too deep or have unsuitable water quality. Local aquifers include alluvial deposits that occur along washes and stream channels, including along the Little Colorado River and its tributaries, sedimentary and volcanic rocks of the Bidahochi and other formations, and some sandstones. The Bidahochi formation forms a local aquifer in the central part of Apache and Navajo Counties and south of Sanders. In the southeastern part of Navajo County, saturated basaltic rocks together with underlying sedimentary rocks are locally known as the Lakeside-Pinetop aquifer, which is an important supply for the area. Undifferentiated sandstones west of Show Low along the Mogollon Rim and in the Springerville-Eager area form aquifers that are also locally important supplies. In the Fort Valley area near Flagstaff, a perched aquifer at a depth of a few hundred feet is utilized (PMCL, 2002). The San Francisco Peaks caldera, known as the Inner Basin, contains an aquifer that supplies much of the municipal water for the city of Flagstaff (<http://cpluhna.nau.edu>).

Surface water is an important supply in some areas, but is geographically limited. The Little Colorado River, the main drainage in the planning area, was formerly perennial throughout its length, but it now flows perennially only from its headwaters to Lyman Lake, north of Springerville (Tellman, et al. 1997). This is primarily due to impoundments, diversions and falling groundwater levels from well pumping. On the Navajo reservation, two-thirds of the average annual surface water originates in the Chuska Mountains and the Defiance Plateau (<http://cpluhna.nau.edu>). Surface water at higher elevations in the southern part of the planning area is available for agricultural use. Colorado River water is the water supply for Page and neighboring LeChee. When there is sufficient rain and snow, surface water is stored in lakes near Flagstaff and used as a municipal supply.

2.0.3 Climate

The Eastern Plateau Planning Area is a semi-arid, relatively high elevation region with cooler average temperatures than in other parts of Arizona. Average annual maximum temperatures in the planning area range from 61° F at Greer to 82°F at Cameron. Annual average temperature is 50.8°F, compared to the state-wide average of 59.9°F. Eastern Plateau temperatures display a long-term warming trend (Figure 2-4), as in other parts of Arizona.

Figure 2-4 Average Temperature And Total Precipitation In The Eastern Plateau Planning Area From 1930-2002.



Horizontal lines are average temperature (50.8 °F) and precipitation (13.0 inches), respectively. Light lines are yearly values and highlighted lines are 5-year moving average values. Data are from selected Western Regional Climate Center cooperative weather observation stations located south of the Little Colorado River.

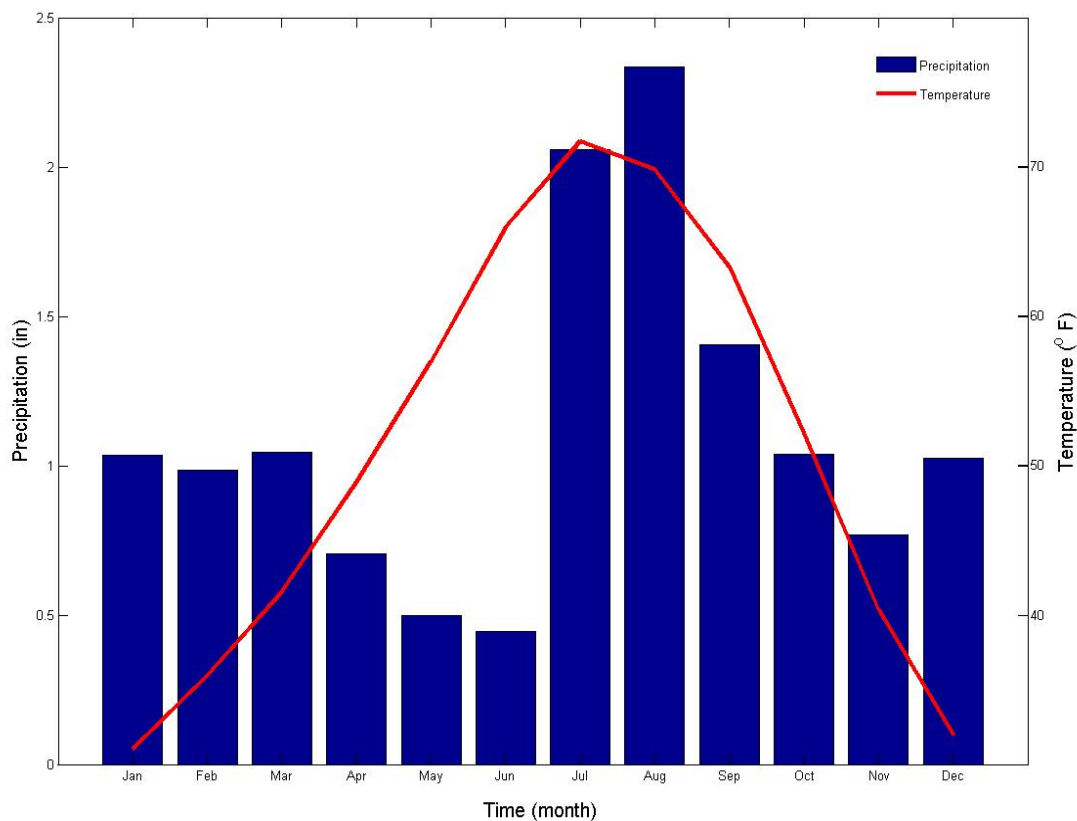
(<http://www.wrcc.dri.edu/summary/climsmaz.html>). Figure author: Ben Crawford, CLIMAS

Parts of the Eastern Plateau downwind of the Central Highlands Planning Area receive diminished precipitation due to the “rain shadow effect.” As moisture-laden air flows over topographic features such as mountain ranges, the air is lifted and cooled, resulting in greater precipitation on the windward side of the mountain. In contrast, the leeward side of mountain ranges receives much less precipitation as the air sinks, warms, and dries, creating a “rain shadow.”

Precipitation in the Eastern Plateau is characterized by a multi-peaked distribution similar to much of Arizona (Figure 2-5). Precipitation is highest during July and August when the area receives over 43% of yearly precipitation, while the driest months on average are April, May, and June. Average annual precipitation ranges from about 4 inches at Monument Valley in the far northeastern part of the planning area to 36 inches in the White Mountains, Mogollon Rim and San Francisco Peak areas. Most of the Navajo and Hopi Reservation lands receive less than 10 inches of rainfall a year. The highest

precipitation on the Navajo reservation is in the Chuska Mountains with an average annual precipitation of 25 inches (Navajo Nation, 2001).

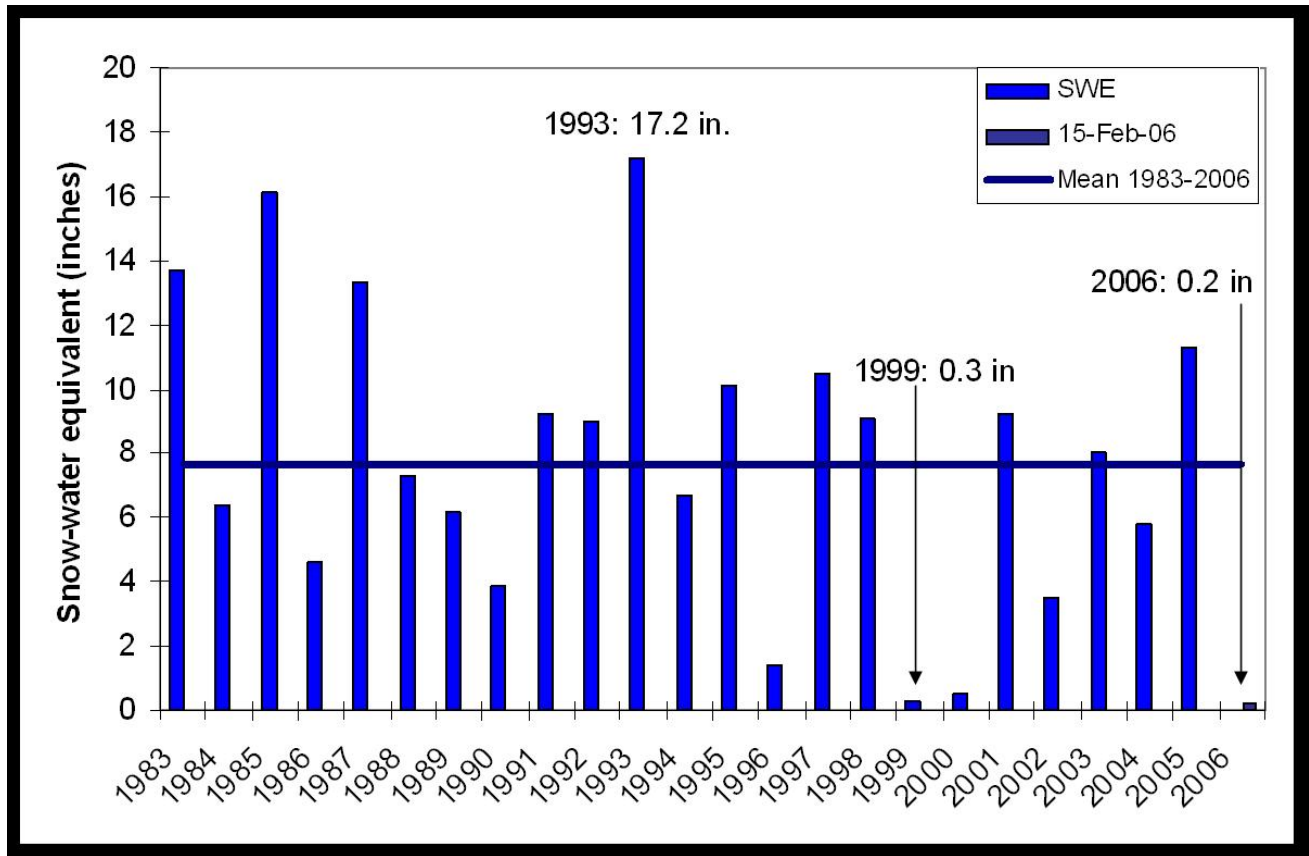
Figure 2-5 Average Monthly Precipitation and Temperature In The Eastern Plateau Planning Area, 1930-2002.



Data are from selected Western Regional Climate Center cooperative weather observation stations located south of the Little Colorado River. (<http://www.wrcc.dri.edu/summary/climsmaz.html>). Figure author: Ben Crawford, CLIMAS.

Much of the state's snowfall occurs along the Mogollon Rim and White Mountains in the Eastern Plateau and Central Highlands Planning Areas. Snowfall is an important water source and is often defined in terms of snow-water equivalent (SWE). SWE is dependent on snow density and describes the amount of liquid water present in a melted sample of snow; light, powdery snow yields less water than dense wet snow. Observations recorded March 1st from 1983 to 2006 at Mt. Baldy in the southeastern portion of the region show SWE variations from 1983 to the present (Figure 2-6). The Mt. Baldy record shows relatively high snow pack during the 1980s and early-to-mid 1990s, followed by substantially lower snow pack since 1999.

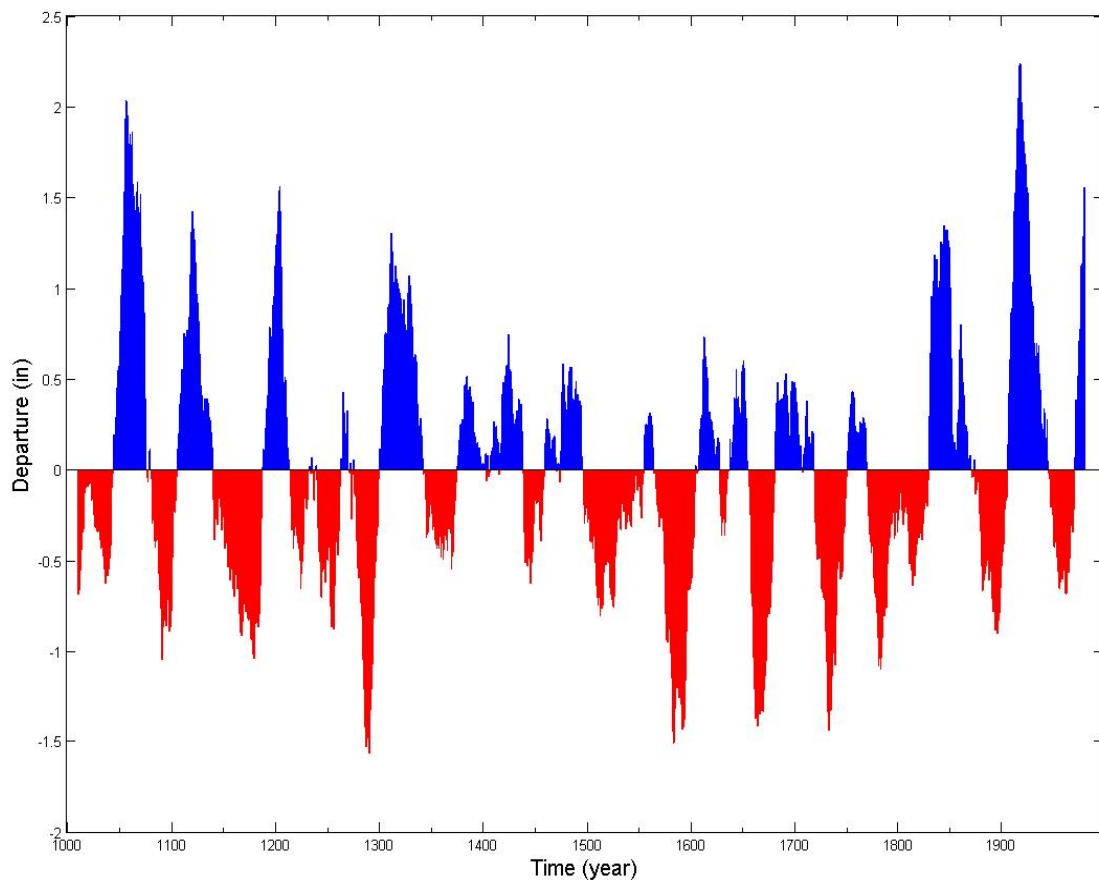
Figure 2- 6 Mt. Baldy Snow-Water Equivalent (SWE) for 1983-2006.



Observations were recorded March 1st for each year except 2006, where February 15 was used. The horizontal, bold line is average SWE from 1983-2006 and highest SWE years (1993) and lowest SWE years (1999 and 2006) are highlighted. Figure author: Casey Thornbrugh, CLIMAS

Two important features of precipitation in this region are variability between individual years, and shifts between wetter and drier than average periods on longer, 10-20 year (decadal) time scales (Figure 2-4 and Figure 2-7). For example, there have been multiple extended periods of above and below-average winter precipitation during every century since 1000 A.D. (Figure 2-7). The 1200s, 1500s, and 1700s were notably dry; in contrast, the mid-1000s, early 1300s, and early 1900s were notably wet. More recently, the 1950s were relatively dry, whereas the 1980s received above-average precipitation (Figure 2-4). These decadal shifts are related to circulation changes in the Pacific Ocean. On time scales of 2-7 years, the well-known El Niño-Southern Oscillation (ENSO) in the Pacific Ocean, with its phases of El Niño and La Niña, is associated with precipitation variations in the region, most notably during winter months (November-April). During El Niño episodes, there is a greater likelihood of increased precipitation; nevertheless El Niño winters can produce below-average precipitation. Generally, La Niña conditions are associated with drought in the region.

Figure 2-7 Arizona NOAA Climate Division 2 (Northeastern Arizona; Coconino, Navajo, and Apache Counties) winter (November-April) precipitation departures from average, 1000-1988, reconstructed from tree rings.



Data are presented as a 20-year moving average to show variability on decadal time scales. The average winter precipitation for 1000-1988 is 6.1 inches. Data: Fenbiao Ni, University of Arizona Laboratory of Tree-Ring Research and CLIMAS. Figure author: Ben Crawford, CLIMAS.

2.0.4 Environmental Conditions

A wide diversity of habitats occurs in the Eastern Plateau Planning Area. Semi-arid grasslands are the largest vegetative community. Other communities include semi-arid scrub vegetation, which predominates along the lower valley of the Little Colorado River near Holbrook, pinyon-juniper woodlands, ponderosa pine forest and mixed-conifer forest communities at high elevations. The forest stretching from near Flagstaff along the Mogollon Rim to the White Mountains region is the largest ponderosa pine forest on the continent. Above about 9,000 feet there are many subalpine grassland parks. Narrow riparian habitats are found in a few areas, primarily along the Little Colorado River and Silver Creek (Abruzzi, <http://cpluhna.nau.edu/Research>).

Due to grazing and fire suppression efforts, pre-settlement environmental conditions have been permanently altered in the region. Woodland communities have expanded considerably and the increase

in ponderosa pine density has led to both an increase in the severity and size of wildfires, and to a decrease in stream and spring flows due to less soil absorption of precipitation (Covington, et al. <http://cpluhna.nau.edu/Research>).

Grazing and other activities have also impacted riparian areas. A number of riparian restoration activities in the Eastern Plateau have been funded by the Arizona Water Protection Fund Program (AWPF) since its inception in 1996. The objective of the AWPF program is to provide funds for protection and restoration of Arizona's rivers and streams and associated riparian habitats. Twenty-five projects were funded in the planning area through 2005. Many of these were for the purpose of fencing and for stream and watershed restoration. A list of projects and types of projects funded in the Eastern Plateau Planning Area through 2005 is found in Appendix A of this volume. (A description of the program, a complete listing of all projects funded, and a reference map is found in Appendix C of Volume 1).

Four applications for instream flow claims have been filed in the Eastern Plateau Planning Area, listed in Table 2-1. An instream flow right is a non-diversionary appropriation of surface water for recreation and wildlife use. As shown in Figure 2-8, the length of the instream flow claims for Chevelon Creek and East Clear Creek are extensive. All claims are located in creeks south of the Little Colorado River.

Table 2-1 Instream flow claims in the Eastern Plateau Planning Area

Map Key	Stream	Applicant	Application No.	Permit No.	Certificate No.	Filing Date
1	Billy Creek	Cartier, David N.	33-94853.0	Pending	Pending	9/14/1989
2	Billy Creek	Walker, F. Duane	33-94847.0	Pending	Pending	9/14/1989
3	Chevelon Creek	Apache-Sitgreaves National Forest	33-96707.0	Pending	Pending	2/13/2002
4	East Clear Creek	Coconino National Forest	33-90107.0	Pending	Pending	7/29/1985

There are a number of listed threatened and endangered species that may be present in the Eastern Plateau Planning Area. Those listed by the USFWS as of January 2006 are shown in Table 2-2. Presence of a listed species may be a critical consideration in water resource management and supply development in a particular area. The USFWS should be contacted for details regarding the ESA, designated critical habitat and current listings.



Stream Data Source: AGFD, 1993 & 1997

Figure 2-8
Eastern Plateau Planning Area
Instream Flow Applications

Reach with Instream Flow Application
 Perennial / Intermittent Stream
 COUNTY
 Interstate Highway
 Major Road
 City, Town or Place



Table 2- 2 Listed threatened and endangered species in the Eastern Plateau Planning Area

(Source: USFWS, 2005)

Common Name	Threatened	Endangered	Elevation/Habitat
Apache Trout	X		>5000 ft./cold mountain streams
Bald Eagle	X		Varies/large trees or cliffs near water
Black-footed ferret		X	<10,500 ft./grassland plains
California Brown Pelican		X	Varies/lakes and rivers
California Condor		X	Varies/high desert canyonlands and plateaus
Chiricahua Leopard Frog	X		3,300-8,900ft./streams, rivers, backwaters, ponds stock tanks
Little Colorado Spinedace	X		4,000-8,000 ft./moderate to small streams in pools & riffles
Loach Minnow	X		<8,000ft./benthic species of small to large perennial streams
Mexican Gray Wolf		X	4,000-12,000 ft. /chapparral, woodland, forests
Mexican Spotted Owl	X		4,100-9,000 ft./canyons, dense forests with multi-layered foliage structure
Navajo Sedge	X		5,700-6,000ft./silty soils at shady seeps and springs
Peebles Navajo Cactus		X	5,400-5,600 ft./gravely soils of the Shinarump conglomerate
San Francisco Peaks Groundsel	X		10,900ft+/-Alpine tundra
Southwestern Willow Flycatcher		X	<8,500 ft./cottonwood-willow and tamarisk along rivers and streams
Zuni Fleabane	X		7,300-8,000 ft./selenium-rich red or gray detrital clay soils derived from the Chinle and Baca formations

2.0.5 Population

In 2000, about 55% of the planning area population resided in the non-reservation portion. Flagstaff is by far the largest community with 38% of the non-reservation population. As shown in Table 2-3, there are many rapidly growing communities including Show Low, Pinetop-Lakeside and Taylor in the White Mountain area and Flagstaff. Some communities grew more rapidly between 2000 and 2005 than during the previous ten year period. There are also rapidly growing communities on the Navajo reservation, with high growth rates in a number of smaller communities.

Table 2-3 Communities In The Eastern Plateau Planning Area with a 2000 Census population greater than 1,000.

Communities are listed from highest to lowest population according to the most recent reported year (2000 or 2005). Source: www.workforce.az.gov

Communities	1990 Census Population	2000 Census Population	Percent Change 1990-2000	2005 Pop. Estimate	Percent Change 2000-2005
Flagstaff	45,857	52,894	15.3	61,185	15.7
Show Low	5,020	7,695	53.3	9,885	28.5
Winslow	9,279	9,520	2.6	9,835	3.3
Page	6,598	6,809	3.2	7,110	4.4
Holbrook	4,686	4,917	4.9	5,425	10.3
Snowflake	3,679	4,460	21.2	4,935	10.7
Eager	4,025	4,033	0.2	4,435	10.0
Pinetop-Lakeside	2,422	3,582	47.9	4,165	16.3
Taylor	2,418	3,176	31.3	4,100	29.1
St. Johns	3,294	3,269	-0.8	3,865	18.2
Heber-Overgaard	1,581	2,722	72.2	NA	--
Springerville	1,802	1,972	9.4	2,065	4.7
Total > 1000	90,661	105,049	15.9	NA	--
Other	20,469	33,284	62.6	NA	--
Total Non-Indian	111,130	138,333	24.5	NA	--
Hopi Reservation	7,360	6,946	-5.6	NA	--
First Mesa/Polacca	1,108	1,124	1.4	NA	--
Navajo Reservation	90,964	104,565	14.9	NA	--
Tuba City	7,323	8,225	12.3	NA	--
Window Rock/Fort Defiance	7,795	7,120	-8.6	NA	--
Chinle	5,059	5,366	6.1	NA	--
Kayenta	4,372	4,922	12.6	NA	--
Kaibito	641	1,607	150.7	NA	--
LeChee	NA	1,606	NA	NA	--
Lukachukai	113	1,565	1,284.9	NA	--
Many Farms	1,294	1,548	19.6	NA	--
Ganado	1,257	1,505	19.7	NA	--
St. Michaels	1,119	1,295	15.7	NA	--
Dilkon	NA	1,265	NA	NA	--
Pinon	468	1,190	154.3	NA	--
Tsaile	1,043	1,078	3.3	NA	--
Total Planning Area	209,454	249,844	19.3	NA	--

2.0.6 Water Supply

Both surface water and groundwater are important water supplies for municipal, industrial and agricultural uses in the Eastern Plateau Planning Area. Due to recent drought conditions, some communities that historically used significant amounts of surface water, such as Flagstaff, have turned to more reliable groundwater supplies. Population growth, supply reliability and the desire for economic development is spurring interest in exploring long-term water supply augmentation options such as securing Colorado River water, constructing water conveyance pipelines, and acquiring lands with groundwater supplies. Effluent is also utilized by several communities for golf course and landscape irrigation.

Surface Water

Surface water is a municipal supply for the cities of Flagstaff and Page and for the town of Eager in the southeastern corner of the planning area. It is also utilized for agricultural irrigation by Indian and non-Indian users. Surface water from the Lake Mary reservoir system is an important municipal supply for the City of Flagstaff. Because surface water is drought sensitive, it can be unreliable, which has spurred interest in additional well drilling and development of groundwater supplies in the Flagstaff area. In wet years, Lake Mary has provided 70% of the City's water supply (PMCL, 2002).

The Salt River Project acquired the rights to the surface water in the C.C. Cragin Reservoir, formerly the Blue Ridge Reservoir, from the Phelps Dodge Corporation in February 2005 as part of the Gila River Indian Water Rights Settlement Act. In addition to satisfying obligations to the Gila River Indian Community, the reservoir will be used to supplement Salt River Project shareholders' water supply and as a water supply for northern Gila County (SRP, 2006). This supply is not available to users in the Eastern Plateau Planning Area.

The domestic water supply for the City of Page and the neighboring Navajo Nation Chapter of LeChee is obtained from Lake Powell through pumping and conveyance facilities first constructed in 1957. This water is available pursuant to a Colorado River Upper basin allocation of 2,740 acre-feet of consumptive use.³ The existing raw water supply facilities marginally meet the current peak demands of the two communities during summer months. A new lake intake to increase capacity and groundwater well development are being considered to provide a more reliable supply (TETRA TECH RMC, 2003). In addition, the City of Page has requested an additional allocation of Colorado River water.

Springs are an important water supply for habitat, wildlife, domestic and cultural/religious purposes. The communities of Tuba City, Moenkopi and Ganado rely on springs for domestic and agricultural uses.

Groundwater

³“Consumption of water brought about by human endeavors....along with the associated losses incidental to these uses.” USBOR, 2004, Colorado River System Consumptive Uses and Losses Report 1996-2000.

It is estimated that groundwater satisfies 90% of the water demand in the planning area. Groundwater is withdrawn from both large regional aquifers and from local and perched aquifers. Flagstaff pumps groundwater from the C-aquifer (Woody Mountain and Lake Mary wellfields) and from shallow volcanic aquifers: the Inner Basin. In 2005, Flagstaff purchased the Red Gap Ranch east of the city as a potential source of groundwater supplies. The cities of Holbrook and Winslow rely entirely on groundwater pumped from the C-aquifer. Groundwater from the C-aquifer and from local aquifers (Bidahochi and Lakeside-Pinetop aquifers) is also the principal water supply for municipal use in the Mogollon Rim region, including the communities of Heber, Pinetop-Lakeside, Show Low, Snowflake, Springerville, Eager, St. Johns and Greer.

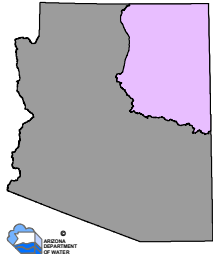
North of the Little Colorado River, including on the Navajo and Hopi reservations, the N-aquifer, which is of good quality, is the primary water supply. In this area the C-aquifer is generally too deep and saline to be used. The D-aquifer underlies much of the Hopi and Navajo reservations and is utilized in some areas, however water quality is marginal due to high concentrations of dissolved solids. The community of Cameron pumps highly saline groundwater from wells near the Little Colorado River and treats it for use.

Effluent

The communities of Flagstaff, Flagstaff Ranch, Holbrook and Page use effluent for golf course and landscape irrigation. In 2003, over 1,600 acre-feet of effluent was used in the Flagstaff area. Reclaimed water is produced by both of the City's wastewater treatment plants. A total of 10 schools, 8 parks, 2 cemeteries, 3 golf courses and a playing field at Northern Arizona University receive treated effluent. In addition, a large industrial user, SCA Tissues, uses effluent in its paper production process. In 2004, the first year of utilization, effluent accounted for 85% of its supply (about 240 acre-feet). Flagstaff also has a reclaimed water hauling program (www.flagstaff.az.gov). Other communities in the planning area discharge effluent to fields for agricultural irrigation or to support wetlands (see Table 2-16).

Contamination Sites

Sites of environmental contamination may impact water supplies. An inventory of Department of Defense, Superfund (Environmental Protection Agency designated sites), Water Quality Assurance Revolving Fund (WQARF, state designated sites), Voluntary Remediation Program (VRP) and Leaking Underground Storage Tank (LUST) sites was conducted for the planning area. There are a number of LUST sites in the planning area. Sites are clustered in urban areas as shown in Figure 2-9. As mentioned in section 1.3.4 of Volume 1, shown are LUST sites where contamination is known or suspected and where remediation is required to meet soil and water quality standards. Four VRP sites are located in the planning area. Under this program, the property owner or other interested party initiates remedial or cleanup actions at a contaminated site on a voluntary basis. VRP sites are located near Flagstaff, Winslow, Joseph City and Springerville. Uranium Mine Tailings Remediation (UMTRA) sites are located on the Navajo reservation that are not mapped on Figure 2-9.



Data Source: ADEQ, 2005.

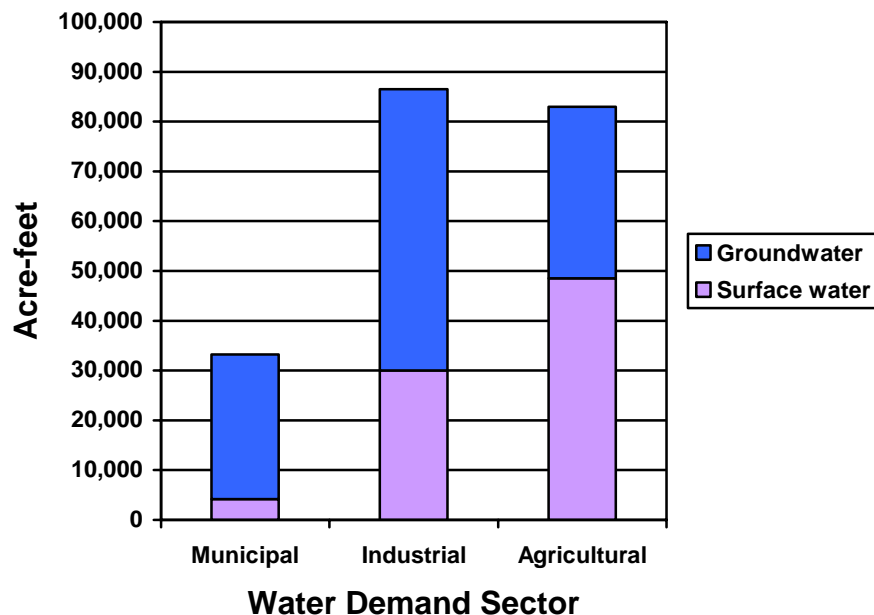
Figure 2-9
Eastern Plateau Planning Area
Contamination Sites

- Leaking Underground Storage Tank (LUST)
- Voluntary Remediation Program
- Consolidated Crystalline and Sedimentary Rocks
- Unconsolidated Sediments
- COUNTY
- Interstate Highway
- Major Road
- City, Town or Place

2.0.7 Cultural Water Demand

The municipal sector is the smallest water demand sector in the Eastern Plateau Planning Area with approximately 33,000 acre-feet of surface water and groundwater demand per year. Industrial demand is the largest use with about 86,500 acre-feet of demand a year, followed closely by agricultural use of about 83,000 acre-feet. As shown in Figure 2-10, surface water is utilized more extensively as a supply by the agricultural sector, accounting for almost 60% of the water supply. Effluent is also used to meet some demands. About 3,000 acre-feet were used in 2003 for municipal sector turf irrigation. Wastewater generated by the Abitibi paper mill near Heber is discharged to a dry lake where it is used to irrigate pasture.

Figure 2-10 Eastern Plateau Planning Area average 2001-2003 cultural water demand (acre-feet)



Municipal Demand

The primary municipal water demand centers in the planning area are located at Flagstaff, Winslow/Holbrook, Page and in the White Mountain/Mogollon Rim communities of Eager, Heber, Pinetop-Lakeside, Overgaard, Show Low, Snowflake, Springerville, St. Johns and Taylor. Estimated water demand in these areas served by public and private water providers is shown in Table 2-4 for each water demand center. Effluent is used by Flagstaff, Page, Eager and Holbrook for golf course and urban irrigation. Four golf courses, Aspen/Elden in Flagstaff, Hidden Cove Country Club in Holbrook and Lake Powell National in Page use 100% effluent from a municipal source.

An estimate of water demand associated with domestic/"self-supplied" wells is also listed in Table 2-4. This number is difficult to estimate. A population-based estimate rather than an estimate based on the

number of domestic wells was used due to uncertainties regarding whether wells drilled are currently functioning. Water hauling is also common in unincorporated areas around Flagstaff and on the Navajo Reservation. Hopi and Navajo reservation demand was estimated using different per capita rates depending on the population density of the area as noted in the footnotes to the table.

Table 2-4 2003 municipal water demand in the Eastern Plateau Planning Area

WATER DEMAND CENTER	2003 Groundwater, Surface Water and Effluent Demand (acre-feet)		
	Groundwater	Surface Water	Effluent
Water Provider¹			
Flagstaff Area	8,800	800	1,650
Heber-Overgaard/Forest Lakes	750	0	0
Page	0	3,120	440
Saint Johns/Concho	660	0	0
Show Low/Pinetop-Lakeside/Vernon	6,500	0	0
Snowflake-Taylor	2,160	0	0
Springerville/Eager	850	120	120
Winslow/Holbrook	4,200	0	75
Total Water Provider	23,920	4,040	2285
Domestic/Self-supplied²	4,000	0	0
Hopi Reservation³	270	160	0
Navajo Nation⁴	6,900	NR	0
Total Municipal	35,090	4,200	2,285

¹ Source; ADWR 2003 and 2004 water provider surveys; USGS and WIFA, 2005

² Unincorporated population of 33,284 @ 107 GPCD

³ Moenkopi served by surface water; reported volume. Remainder of population, 6,045 @ 40 GPCD (from Table 3, Truini et al., 2005)

⁴ Tuba City, Window Rock, Chinle and Kayenta population @ 94 GPCD (from pumpage data for Tuba City and Kayenta in Table 3, Truini et al., 2005). Census 2000 redistricting data for other Navajo communities found a population of 22,743 @ 65 GPCD (from pumpage data for Chilchinbito, Dennehotso and Rough Rock in Table 3, Truini et al., 2005). Remaining Navajo population of 56, 189 @ 40 GPCD (from Table 3, Truini et al., 2005).

NR = not reported; supply is utilized but volume not available.

Municipal water demand is primarily residential and commercial. Demand varies seasonally in some communities due to tourism and to summer-only landscape watering. Because of the higher elevation, shorter growing season, higher rainfall, and rural nature of many parts of the planning area, outdoor landscape watering is typically lower than that in the lower elevation, drier parts of the state. There have been significant conservation efforts in the Flagstaff area. Some of these programs target outdoor water use and landscape design, e.g. rebates for replacement of high water use landscaping. Estimated per capita usage in Flagstaff is 120 gallons per capita per day (GPCD), which is lower than many cities in Arizona (www.flagstaff.az.gov). Public municipal systems serve the majority of water demand in the planning area. Non-Indian large utility systems are listed in Table 2-5.

Table 2-5 Water providers serving 500 acre-feet or more of water per year, excluding effluent, in the Eastern Plateau Planning Area (Source: USGS, ADWR)

Water Provider	1991 (acre-feet)	2000 (acre-feet)	2003 (acre-feet)
Arizona Water Company-Lakeside	597	897	600
Arizona Water Company-Overgaard	183	337	500
Doney Park Water	455	737	751
Eager Municipal Water	680	781	685
Flagstaff, City of	8,172	9,927	8,493
Holbrook, City of	NA	NA	1,369
Page Municipal	2,740	2,740	3,000
St. Johns Municipal	NA	NA	557
Snowflake, Town of	872	1,323	1,473
Taylor, Town of	445	721	720
Winslow Municipal	NA	NA	2,762

NA = Not available

Major municipal demand centers on reservation lands include Chinle, Kayenta, Tuba City, and Window Rock/Fort Defiance on the Navajo reservation, and to a lesser extent, Polacca on the Hopi reservation. Specific amounts used in each community are not known. According to a 2002 Navajo Department of Water Resources (NDWR) report, approximately 40% of the population routinely hauls water for domestic and stock uses. According to the report, the Navajo Nation has the highest percentage of its population lacking potable water systems compared to any other region in the United States. Most municipal water supplies are groundwater (NDWR, 2002).

The Navajo Tribal Utility Authority (NTUA) is the largest public water provider on the Nation, which extends into New Mexico and Utah. Data for Arizona only was not available. Throughout the entire reservation, the NTUA operates more than 90 public water systems with approximately 24,000 connections, supplying more than 12,000 acre-feet of residential and 3,300 acre-feet of commercial water per year. It is estimated that smaller operators (NDWR and BIA) serve about 10,000 people and convey about 1,500 acre-feet of water. About 500 acre-feet of wastewater is used for dust abatement and construction. Other major uses are associated with coal mining on Black Mesa and electrical generation (NDWR, 2002).

Hopi municipal water use is assumed to be low. The Hopi village of Moenkopi, with a population of about 900, uses approximately 160 acre-feet of water from springs. Some of this may be used for irrigation. Assuming 40 GPCD (Truini, et al., 2005) for the approximately 6,000 Hopi tribal members living on other tribal lands, municipal water use is estimated at 430 acre-feet per year. The N-aquifer is the only aquifer of sufficient quality and accessibility to supply reliable drinking water to the Hopi villages on the three mesas (www.hopi.nsn.us).

Agricultural Demand

Agricultural demand is not well documented in the planning area. Estimates contained in this section are generally based on older reports or records. Cessation of some agricultural irrigation has occurred recently in the Hunt Valley area and near St. Johns due to purchase by the Zuni Tribe to preserve tribal water resources at Zuni Heaven, an historically riparian area sacred to the Zuni.

Areas of greatest non-Indian agricultural irrigation are near the communities of Saint Johns, Springerville, Snowflake/Taylor and Joseph City/Holbrook. Agricultural irrigation on the Navajo reservation is assumed served primarily by surface water and land is also dryland farmed. Dryland farming utilizes water harvesting techniques to catch and direct runoff to crops. Because there is no supplemental irrigation, both spring soil moisture and late summer precipitation are needed for success. It is estimated that approximately 34,000 acres in the planning area are actively irrigated with a combination of 83,000 acre-feet of surface and ground water. Agricultural demand is summarized in Table 2-6.

Table 2-6 Agricultural demand in selected years in the Eastern Plateau Planning Area

	1991	2000	2003
	Water Use (acre-feet)		
Non-Indian Total	76,700	71,100	71,500
Surface Water	39,700	37,000	37,000
Groundwater	37,000	34,500	34,500
Indian Total	12,800	12,000	12,000
Surface Water	12,400	11,600	11,600
Groundwater	400	400	400
TOTAL	89,500	83,500	83,500

Note: agricultural use and source is a general estimate derived primarily from older sources.

Estimated total 2003 active irrigated acres is 31,200 acres; 26,900 acres of non-Indian acreage and 4,300 acres of Indian acreage.

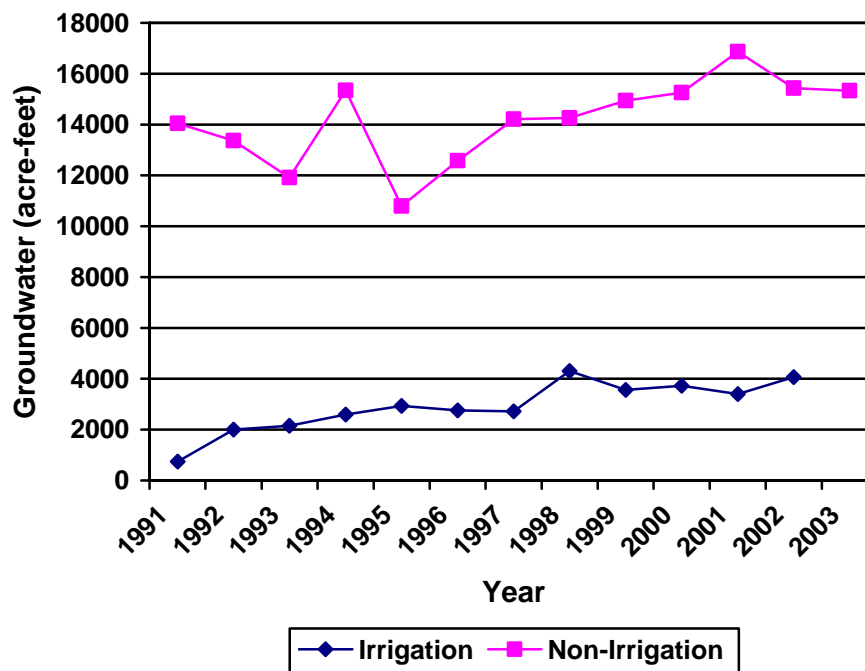
Silver Creek Watershed-Pinetop-Lakeside, Show Low, Snowflake

There are two irrigation companies in the Show Low/Pinetop-Lakeside area, the Show Low Pinetop Woodlands Irrigation Company and the Lakeside Irrigation System. The irrigation season is limited and irrigated lands are used for pasture, orchards and gardens. Commercial agriculture is declining in the area. The Silver Creek Irrigation District operates in the communities of Shumway, Taylor and Snowflake. Both areas are within the Silver Creek Watershed for which a Hydrographic Survey Report was filed with the Adjudication court in 1990. At that time, the investigations showed that almost 6,300 acres were irrigated with surface water and groundwater, using a total of almost 29,000 acre-feet per year.

Joseph City Irrigation Non-Expansion Area (INA)

The Joseph City INA was established in 1980 by the Arizona Groundwater Management Act. The area had previously been designated as a Critical Groundwater Area in 1974. Designation of an area as an INA recognizes that there is “insufficient groundwater to provide a reasonably safe supply for the irrigation of the cultivated lands at the current rate of withdrawal” A.R.S. § 45-402(22). Within an INA, irrigation with groundwater is restricted to lands that were irrigated prior to establishment of the area. Groundwater withdrawals by irrigation and large non-irrigation users, such as cities or golf-courses, must be reported annually to the Department. Irrigation and non-irrigation uses (primarily the Cholla Generating Station), are shown in Figure 2-11. Irrigation use in the INA is generally between 2,000 and 4,000 acre-feet a year, served by the Joseph City Irrigation Company. Complete data for 2003 was not available.

Figure 2-11 Groundwater withdrawals for irrigation and non-irrigation uses in the Joseph City INA, 1991- 2003.



Upper Little Colorado River-Springerville, Nutrioso, Greer, Vernon, St. Johns, Concho

The Department conducted an inventory of irrigation use in the Upper Little Colorado River watershed and published a report in 1994 (ADWR, 1994a). The inventory divided the area into ten regions: Nutrioso; Greer; Round Valley, including the Round Valley Water Users Association and Springerville Water Rights and Ditch Company; Vernon; St. Johns including Lyman Water Company and the St. Johns Irrigation Company; Concho, including Concho Water Company; Hunt; Hay Hollow; Woodruff, including the Woodruff Irrigation Company and Sanders. At that time 18,980 acres were irrigated with a total surface water and groundwater use of almost 35,000 acre-feet. The highest volumes of water use were in the St. Johns area (6,600 acre-feet) and in the Hunt Valley area, located west of St. Johns (3,800 acre-feet). The cropped acres were primarily pasture. No use was reported in the Sanders region. As mentioned previously, the Zuni tribe has recently purchased and retired agricultural lands in the Hunt Valley area and near St. Johns.

Lower Little Colorado River-Winslow, Holbrook, Heber, Flagstaff

The Department conducted an inventory of irrigation use in the Lower Little Colorado River watershed and published a report in 1994 (ADWR, 1994b). Similar to the Upper Little Colorado River watershed inventory, the area was divided into four regions, Winslow, Holbrook, Heber and Flagstaff. At the time of the inventory, (excluding the Joseph City Irrigation Company located in the Joseph City INA), about 3,700 acres were actively irrigated with a combination of 10,600 acre-feet of surface water and groundwater. Use was reported in three of the regions: 4,380 acre-feet per year at Winslow; 3,300 acre-feet per year at Heber; and 2,900 acre-feet per year at Holbrook. Pasture and alfalfa were the primary crops grown. No irrigation was reported in the Flagstaff region.

Navajo Reservation

In Arizona, Navajo reservation irrigation consists of Ak Chin (dryland farming) and small irrigation projects. Between 1910 and the late 1950's the U.S. Government built and expanded dozens of small irrigation projects amounting to about 46,200 acres reservation-wide. Because of inadequate management and funding for operation and maintenance, these small systems have deteriorated and by 1986, an SCS survey found only 16,670 acres still were farmed, a decrease of 64% (NDWR, 2002).

A field study conducted by Department staff in the portion of the Navajo Reservation in the Upper Basin portion of the Colorado River Basin, found less than 900 acres of active irrigation, entirely with surface water. Another 500 acres in the Upper Basin was identified as being dryland farmed.

Hopi Reservation

Agriculture on the Hopi reservation consists primarily of dryland farming on an estimated 300 acres of land. A survey is being conducted at the time of this publication to better quantify agricultural water demand and supply on the Hopi lands.

Industrial Demand

Industrial water demand in the planning area includes mining, electrical power generation, paper production, dairies and feedlots and golf course irrigation served by a facility water system. This demand is summarized in Table 2-7 for selected years. Industrial demand, particularly for power generation is a large cultural demand component in the planning area, representing about 30% of the total planning area demand in 2003.

Table 2-7 Industrial demand in selected years in the Eastern Plateau Planning Area

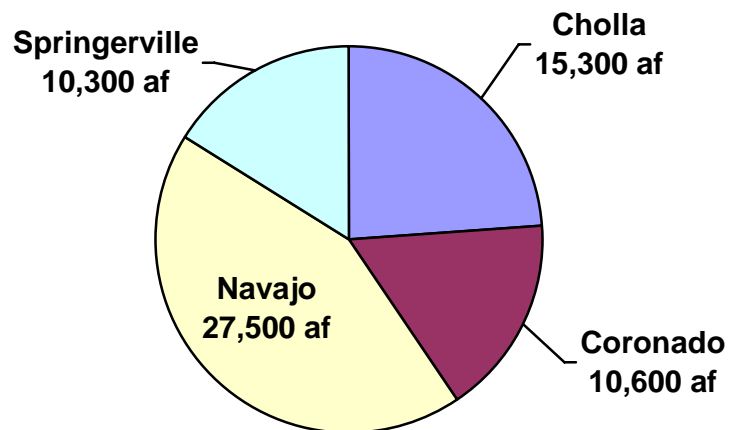
Type	1991	2000	2003
	Water Use (acre-feet)		
Mining Total	7,052	6,953	4,700
Surface water*	2,852	2,053	0
Groundwater	4,200	4,900	4,700
Power Plant Total	51,366	61,709	62,484
Surface water	23,866	28,709	26,284
Groundwater	27,500	33,000	36,200
Golf course Total	1,679	1,829	1,692
Surface water	87	87	87
Groundwater	1,592	1,742	1,605
Dairy/Feedlot Total	536	24	520
Surface water	0	0	0
Groundwater	536	24	520
Paper Mill Total	17,677	13,617	13,562
Surface Water	0	0	0
Groundwater	17,677	13,617	13,562
TOTAL	78,310	84,132	82,958

* diverted pursuant to an exchange agreement between Phelps Dodge Corporation and the Salt River Valley Water Users Association. Phelps Dodge provides water to SRP from Show Low Lake but this water is accounted for as water used by the Morenci Mine in the Southeastern Arizona Planning Area

Mine water use includes sand and gravel operations, the coal mines on Black Mesa south of Kayenta and surface water diversions from Show Low Lake and Blue Ridge/C.C. Cragin Reservoir for mining use outside the planning area. Peabody Coal company operates two mines on Black Mesa: the Black Mesa Coal Mine and the Kayenta Mine, the largest coal strip mining operation in the world. These mines annually ship approximately 12 million tons per year of low-sulfur subbituminous coal and pump approximately 4,400 acre-feet per year. Over 3.8 million gallons of groundwater per day are required to slurry coal to the Mohave Generating Station near Laughlin, Nevada. Coal is also sent to the Navajo Generating Station at Page by rail (<http://cpluhna.nau.edu>). At the time of publication, the 273-mile slurry pipeline was not operating because of Southern California Edison's failure to upgrade pollution control devices at the Mohave Generating Station, as required by a lawsuit brought by a consortium of environmental groups.

Powerplants include the Navajo Generating Station, the Coronado Generating Station located six miles northeast of Saint Johns, the Springerville Station located northeast of Springerville and the Cholla Generating Station near Joseph City. Use at the Cholla Generating Station for the period 1991-2003 is shown in Figure 2-11. The Navajo Generating station uses water from Lake Powell pursuant to an Upper Basin Colorado River contract which entitles it to receive up to 34,000 acre-feet of water per year. In recent years it has diverted about 27,500 acre-feet a year. All other facilities pump groundwater. Demand in acre-feet for 2003 is shown in Figure 2-12 below.

Figure 2-12 Water demand by electrical generating stations in the Eastern Plateau Planning Area in 2003.



There are eleven industrial golf courses in the planning area, including six in the Pinetop-Lakeside/Show Low area. In 2003, a total of about 1,700 acre-feet of primarily groundwater was used. Because of cooler temperatures, higher precipitation and short growing season, relatively little water is required for golf course irrigation at most locations.

In 2003, an estimated 124,000 swine were raised at four feedlot facilities near Snowflake. These feedlots have been in existence since the early 1980s. A small dairy is located near Taylor. Combined water demand by the dairy and feedlots is typically between 450 to 600 acre-feet a year.

The Abitibi paper mill, formerly Stone Container Corporation, operates about 23 miles southwest of Holbrook. Waste water from the operation is discharged to Dry Lake and is used to irrigate pasture east of SR 377. In 2005, approximately 11,900 acre-feet of effluent was generated while 14,000 acre-feet was pumped. This suggests that about 85% of the annual groundwater withdrawal is recovered and used for irrigation.

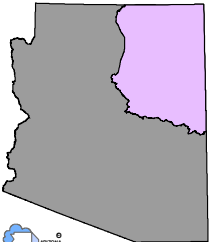
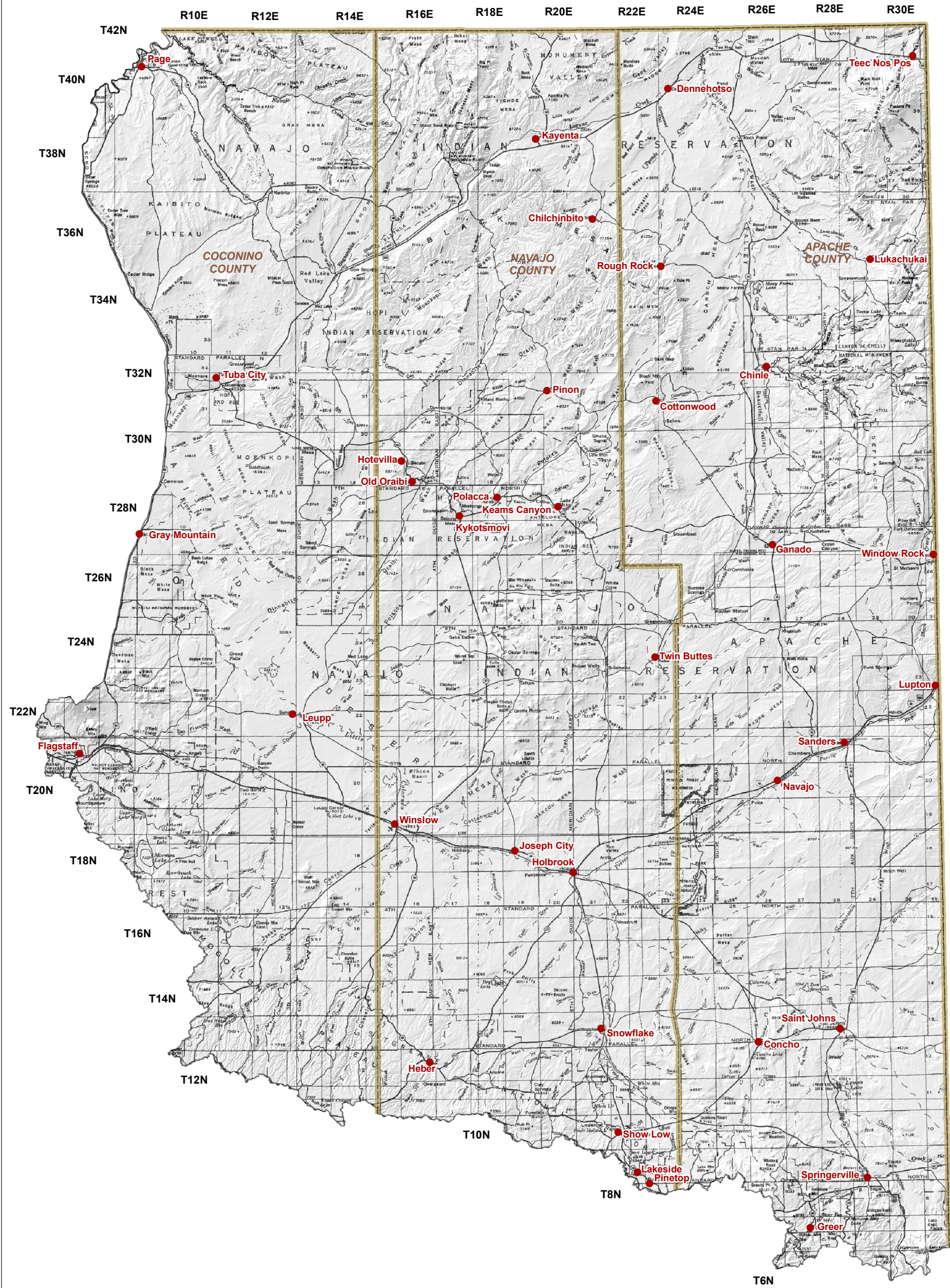
SECTION 2.1 Water Resource Characteristics of the Little Colorado River Plateau Basin

The following subsections present data and maps related to water resource characteristics of the Little Colorado River Plateau Basin, the only groundwater basin in the Eastern Plateau Planning Area. A description of the data sources and methods used to derive this information is found in Section 1.3 of Volume 1 of the Atlas.

2.1.1 Geography of the Little Colorado River Plateau Basin

The Little Colorado River Plateau Basin is the largest groundwater basin in the state. Geographic features and principal communities are shown on Figure 2-13. Located at the southern end of the Colorado Plateau, it is characterized by relatively high elevation, semi-arid mesas and several high elevation mountain ranges. Elevations generally increase from north to south.

- Principal geographic features shown on Figure 2-13 are:
 - Monument Valley north of Kayenta
 - Kaibito Plateau south of Page
 - Painted Desert, located between Gray Mountain and Winslow
 - Defiance Plateau, running north/south near Window Rock
 - Black Mesa in the vicinity of Chilchinbito
 - Canyon de Chelly, near Chinle
 - First, Second and Third Mesas on the Hopi Reservation
 - Petrified Forest located between Holbrook and Navajo
 - Mogollon Plateau or Mogollon Rim stretching 200 miles from Flagstaff to the White Mountains
 - Lukachukai and Chuska Mountains near Lukachukai
 - The Little Colorado River, which flows to the Colorado River from the headwaters near Greer, and exits the basin at Cameron north of Gray Mountain.
- Though not well shown on Figure 2-13, the San Francisco Peaks north of Flagstaff and the White Mountains along the southeastern boundary of the basin are prominent geographic features. An isolated peak, Navajo Mountain, straddles the Arizona-Utah border east of Page. Rising to over 10,400 feet it is a prominent visual feature of the basin.
- Humphreys Peak in the San Francisco Peaks is the highest point in Arizona at 12,633 feet.
- The White Mountains rise to over 11,000 feet at Mt. Baldy.
- Principal basin communities are shown and were selected based on population, cultural relevance or for locational purposes.



Base Map: USGS 1:500,000, 1981

Figure 2-13
Little Colorado River Plateau Basin
Geographic Features

2.1.2 Land Ownership in the Little Colorado River Plateau Basin

Land ownership, including the percentage of each ownership category is shown in Figure 2-14. Principal features of land ownership are the large amount of tribal lands, the continuous band of national forest lands along the southern and southwestern boundary of the basin, and the “checkerboard” pattern of land ownership south of the reservation lands. This distribution of land ownership has implications for land management and water development and use. A description of land ownership data sources and methods is found in Volume 1, Section 1.3.8

A key land ownership feature in the basin is the significant amount of private lands interspersed with state trust lands and to a lesser extent federal lands in a checkerboard pattern south of the Navajo Reservation. Prior to 1871, federal land grants of alternating one-square-mile sections of land along the right-of-way were given to railroads to promote railroad expansion. In addition, the State Enabling Act of 1910 and the Act that established the Territory of Arizona in 1863 set aside sections 2, 16, 32 and 36 in each township to be held in trust by the state for educational purposes. Other legislation authorized additional state trust lands. Where the “school” section lands were previously claimed or on federal reservations, national forest, park or Indian reservations, the state was given the right to select an equal amount of acreage of Federal land. The state is also allowed to trade lands for other federal lands or private lands to block up Trust land holdings (www.land.state.az.us/history.htm). These decisions have resulted in the pattern observed in the basin. Land ownership categories are discussed below in the order of percentage from largest to smallest in the basin.

Indian Reservations

- 63.9% of the land in the Little Colorado River Plateau Basin is under tribal ownership.
- Of the 27,000 square miles of Navajo nation lands in Arizona, New Mexico and Utah, more than 13,000 square miles are in Arizona.
- Navajo tribal lands include parts of Apache, Navajo and Coconino Counties.
- Window Rock is the location of the Navajo tribal headquarters.
- The Hopi reservation encompasses about 2,400 square miles (1.5 acres) in parts of Navajo and Coconino counties.
- The Hopi reservation is primarily comprised of three mesas and tribal communities at Lower and Upper Moenkopi east of Tuba City. Hopi people have continually occupied the area since 500 A.D. and the community of Old Oraibi, established as early as 1,100, is considered the oldest continuously inhabited settlement in the United States. The Hopi Tribal Headquarters are located in Kykotsmovi on Third Mesa (www.azcommerce.com).
- There are areas north of Joseph City under Hopi and Navajo ownership.
- Other tribal lands include those of the Zuni (about 8 square miles) north of Concho and White Mountain Apache lands (about 4.5 square miles) southwest of Greer. The Zuni tribal lands in Arizona, “Zuni Heaven”, were formally recognized in 2004. The Zuni also hold large, non-reservation ranch holdings in and around their reservation.
- The Hopi Tribe holds large, non-reservation ranch holdings in the checkerboard lands area including deeded land, state leased property and Forest Service lands.
- Primary land uses are grazing, mining and farming.

Private

- 14.8% of land ownership in the basin is private.
- Private lands are primarily located in areas surrounding non-Indian communities and in the area between Winslow and the New Mexico border south of the Navajo reservation and north of National Forest lands.
- Private land in-holdings are located within National Forest lands in the Nutrioso area southeast of Springerville and to a lesser extent in other areas as shown.
- Primary land uses are domestic, industrial and commercial.

National Forest and Wilderness

- 10.5% of land is National forest and wilderness. There are two forest districts, the Coconino and Apache Sitgreaves.
- Forest lands contain the headwaters of most of the major streams and of the only major river in the basin.
- Primary land uses are grazing, recreation and logging.

State Trust

- 8% of lands are held in trust for public schools and 13 other beneficiaries under the State Trust Land system.
- There is a large amount of contiguous state land ownership between Springerville and Saint Johns and another contiguous area adjacent to national forest lands southeast of Flagstaff.
- Most land uses are for livestock grazing.

Parks, Monuments, Historical and Recreational Sites

- 1.4% of lands are under federal or state ownership as parks, monuments and other sites.
- Sites identified on Figure 2-14 include a small portion of the Glen Canyon National Recreation Area, Canyon De Chelly National Monument, Wupatki National Monument, Petrified Forest National Park, Sunset Crater National Monument, Walnut Canyon National Monument.
- Primary land use is for recreational purposes.

U.S. Bureau of Land Management

- 1.2% of lands are under federal ownership by the Bureau of Land Management.
- All lands are included in the checkerboard pattern of land ownership in Navajo and Apache counties.
- Primary land uses are for livestock grazing.

Other (Arizona Game and Fish, County and Bureau of Reclamation Lands)

- 0.1% is held by other landowners.
- These lands are located in the vicinity of Springerville, southeast of Flagstaff and there are a few sections scattered in the checkerboard lands.
- Primary land uses on Arizona Game and Fish lands is for wildlife conservation.



2.1.3 Climate of the Little Colorado River Plateau Basin

Climate data from four types of meteorological stations are compiled in Table 2-8 and their location is shown on Figure 2-16. A description of the climate data sources and methods is found in Volume 1, Section 1.3.3.

NOAA/NWS Coop Network

- Refer to Table 2-8A
- There are 56 NOAA/NWS Coop network climate stations reported in the Basin although information is not available for 2 of them.
- Stations are widely dispersed throughout the basin.
- Of the 54 stations for which information is available, data from different periods of record may be used as shown. This may be due to discontinued measurements, date of installation or other availability issues.
- Station elevation ranges from 4,160 feet at Cameron 1 NNE to 8,490 feet at Greer.
- Maximum average temperatures range from 61.5°F at Greer to 81.7°F at Page.
- Minimum average temperatures range from 27.0°F at Fort Valley to 36.5°F at Cameron 1 NNE.
- Station precipitation varies considerably with an annual average precipitation range of 4.09 inches at Monument Valley to 28.46 inches at McNary 2 N.
- Additional precipitation data shows rainfall as high as 36 inches at sites along the Mogollon Rim and near Flagstaff
- Almost all stations report highest average precipitation during the summer season (July-September).
- On average, the driest season is spring (April-June).
- Altitude is a factor in precipitation, however the rain shadow effect results in greater precipitation on the windward side as storms move northeastward. Blue Ridge Ranger Station at 6,880 feet received an average of 20.6 inches of rainfall a year while Betatakin, at 7,290 feet received only 12.81 inches.

Evaporation Pan

- Refer to Table 2-8B
- There are three sites in the basin at Flagstaff, Page and Winslow.
- Of these sites, the lowest evaporation rate is at Flagstaff, elevation 7,010 feet, and the highest is at Winslow, elevation 4,890 feet.

AZMET

- Refer to Table 2-8C
- There is one AZMET station in the basin, located at Flagstaff at an elevation of 6,747 feet. Average annual reference evaporation is similar to that at the Flagstaff WB AP site.

SNOTEL/Snowcourse

- Refer to Table 2-8D
- There are data from twenty snow measurement sites in the basin, more than any basin in the state. Four sites have been discontinued.

- Elevations at current sites range from 6,930 feet at Lake Mary to 11,200 feet at Snow Bowl #2.
- High elevation sites (>8,000 feet) in the vicinity of Flagstaff typically continue to accumulate snowpack into April.
- High elevation sites (>8,000 feet) in the Beaver Springs and Tsaile Canyon areas report highest average snowpack in March.
- Sites <8,000 feet generally show highest snowpack in March/February.
- Highest average snowpack is found at three stations near Flagstaff and a station at Mount Baldy (Baldy #2).
- There is a correlation between elevation and the average snowpack at the beginning of the month with the highest measurement as shown in Figure 2-15. However, location of the site, even those in close proximity to each other, and the period of record affect snowpack accumulation averages.

Figure 2-15 Relationship of elevation to highest monthly average snowpack in the Little Colorado River Plateau Basin.

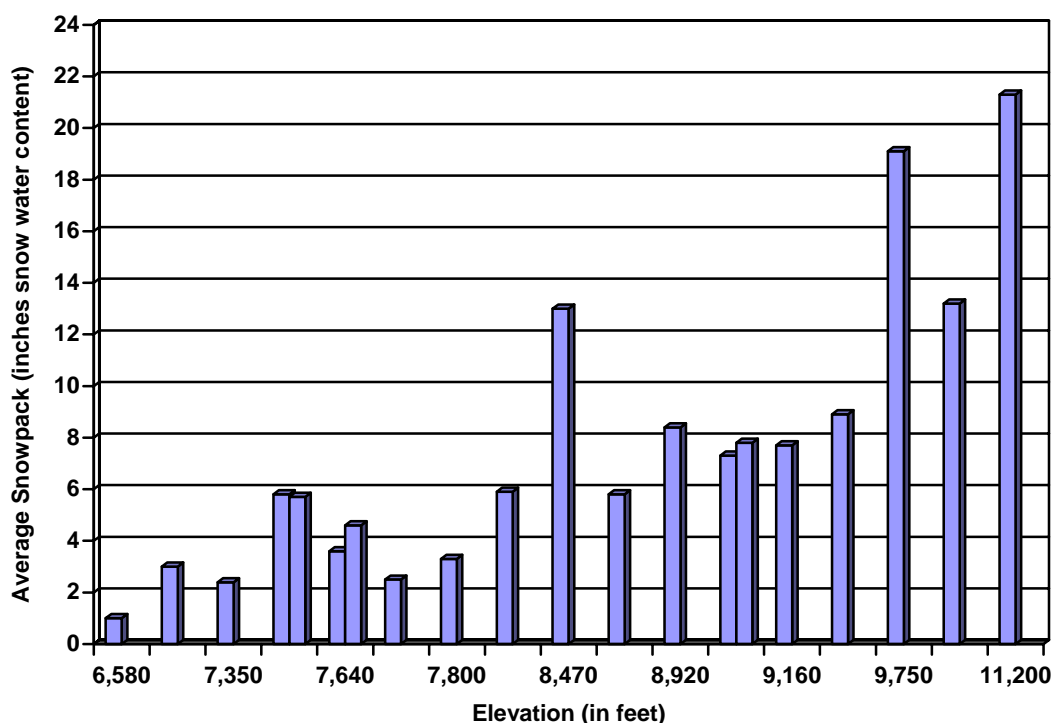


Table 2-8 Climate Data for the Little Colorado River Plateau Basin

B. Evaporation Pan:

Station Name	Period of Record Used for Averages	Elevation (in feet)	Avg. Annual Evap (in inches)
Flagstaff WB AP	1968 - 1978	7,010	54.00
Page	1957 - 2002	4,270	80.57
Winslow AP	1990 - 1999	4,890	84.7

C. AZMET:

Station Name	Period of Record	Elevation (in feet)	Average Annual Reference Evapotranspiration, in inches (number of years to calculate average)
Flagstaff	11/2003 - current	6,747	55.48 (2)

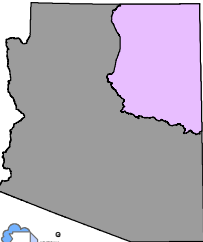
D. SNOTEL/Snowcourse:

Station Name	Period of Record Used for Averages	Elevation (in feet)	Average Snowpack at Beginning of Month, as Inches Snow Water Content (Number of measurements to calculate average)					
			Jan.	Feb.	March	April	May	June
Arbabs Forest	1985 - current	7,680	1.2(18)	2.5(20)	1.9(19)	0.2(20)	0(0)	2.4(1)
Baldy (SNOTEL)	1950 - current	9,125	3.7(33)	6.0(54)	7.8(54)	6.6(54)	0.4(19)	0(17)
Baldy #1	1950 - 1999 (discontinued)	9,125	3.7(28)	5.7(49)	7.3(50)	6.4(49)	0.8(22)	0(21)
Baldy #2	1963 - 1997	9,750	0(0)	12.3(2)	0(0)	19.1(9)	25.2(1)	0(0)
Beaver Spring	1986 - current	9,220	3.8(16)	6.9(17)	8.9(16)	7.3(18)	0(0)	0(0)
Cheese Springs	1969 - current	8,700	2.6(26)	4.2(36)	5.8(36)	3.9(36)	0(1)	0(0)
Fort Apache	1951 - current	9,160	3.7(25)	6.0(52)	7.7(54)	7.0(54)	0(0)	0(0)
Fluted Rock	1985 - current	7,800	1.3(18)	2.9(20)	3.3(19)	0.6(20)	0(0)	0(0)
Forestdale Alt.	1984 - 1989 (discontinued)	6,580	0.5(6)	1.0(6)	0.6(6)	0(6)	0(0)	0(0)
Fort Valley	1947 - current	7,350	1.3(30)	2.3(58)	2.4(58)	1.0(57)	0(1)	0(0)
Heber	1950 - 1999 (discontinued)	7,640	1.8(23)	3.5(49)	3.6(49)	2.1(46)	1.0(2)	0(0)
Heber (SNOTEL)	1950 - current	7,640	2.2(29)	4.5(54)	4.6(54)	2.4(50)	0(22)	0(22)
Lake Mary	1975 - current	6,930	1.3(25)	2.5(30)	3.0(30)	0.4(30)	0(0)	0(0)
Mormon Mountain	1950 - 1999 (discontinued)	7,500	2.8(30)	4.8(49)	5.8(50)	4.2(47)	5.1(3)	0(0)
Mormon Mountain (SNOTEL)	1950 - current	7,500	2.5(35)	4.5(54)	5.7(55)	4.2(52)	1.1(25)	0(22)
Mormon Mountain Summit #2	1975 - current	8,470	3.8(14)	7.5(20)	11.7(22)	13.0(27)	0(0)	0(0)
Snow Bowl #1 Alt.	1984 - current	9,920	5.3(20)	7.9(21)	11.7(21)	13.2(20)	0(0)	0(0)
Snow Bowl #2	1965 - current	11,200	7.8(27)	11.8(39)	16.7(39)	21.3(38)	0(0)	0(0)
Tsaile Canyon #1	1985 - current	8,160	2.6(19)	5.1(20)	5.9(19)	3.2(20)	0(0)	0(0)
Tsaile Canyon #3	1986 - current	8,920	3.6(18)	6.9(19)	8.4(18)	6.6(19)	0(0)	0(0)

WB = Weather Bureau

AP = Airport

Alt = Alternate



Precipitation Data Source: Oregon State University, 1998

0 6 12
Miles



Figure 2-16
Little Colorado River Plateau Basin
Meteorological Stations
and Annual Precipitation

Average Annual
Precipitation
(1961-1990)

inches per year			
4-6	22-24	24-26	26-28
6-8	24-26	26-28	28-30
8-10	26-28	28-30	30-32
10-12	28-30	30-32	32-34
12-14	30-32	32-34	34-36
14-16	32-34	34-36	36-38
16-18	34-36	36-38	38-40
18-20	36-38	38-40	
20-22	38-40		

Meteorological Stations

NOAA/NWS	◆
NRCS Snow	◆
AZMET	◆
Pan ET	◆
Precipitation Contour	12
COUNTY	
Interstate Highway	
Major Road	
City, Town or Place	●

2.1.4 Surface Water Conditions of the Little Colorado River Plateau Basin

Streamflow data, including average seasonal flow, annual flow and other information is shown in Table 2-9. Flood ALERT equipment in the basin as of September 2004 is shown in Table 2-10. Reservoir and stock pond data including maximum storage or maximum surface area of large reservoirs and type of use of the stored water is shown in Table 2-11. The location of streamflow and flood gages, using the USGS or station ID number, is shown on Figure 2-17. The location of large reservoirs is also shown on Figure 2-17 and keyed to Table 2-11A. A description of the stream data sources and methods is found in Volume 1, Section 1.3.16. A description of reservoir data sources and methods is found in Volume 1, Section 1.3.11. A description of stockpond data sources and methods is found in Volume 1, Section 1.3.15.

Streamflow Data

- Refer to Table 2-9
- Criteria for including stations are that there is at least one year of record, and annual streamflow statistics are included only if there are at least three years of record. Seasonal flow information provides data relevant to seasonal surface water availability. Annual flow volumes (in acre-feet) provide an indication of potential volumetric availability of the surface water supply.
- Data from forty-five stations, including 21 discontinued stations, are shown in the table and on Figure 2-17.
- The average seasonal flow as a percentage of annual flow is highest in the Spring (April-June) from winter snowmelt and spring rains and in the Summer (July-September) from high intensity monsoon storms.
- High summer season percentages were noted at many gages on the Navajo and Hopi reservation. High winter flow percentages (January-March) were recorded at gages near Lakeside, Show Low and Snowflake.
- The year of minimum and maximum flow varies depending on the location and period of record. For the 11 active gages in existence prior to 1990, 8 reported that the minimum year of flow occurred during the period 1990 to 2004. For these same gages, the maximum year of flow was more variable. However, the largest percentage (36%) recorded maximum flows during the 1980s.

Flood ALERT Equipment

- Refer to Table 2-10
- There were 32 stations in the basin as of October 2005. Stations vary in type. Some are precipitation stations only while others include stage information and also serve repeater functions. Stations that are only repeaters are not included.
- Flood gage information is presented to direct the reader to sources of additional precipitation and flow information that can be utilized in water resource planning.

Reservoirs and Stock Ponds

- Refer to Table 2-11
- Surface water is stored or could be stored at 92 large reservoirs and 685 small reservoirs in the basin.

- Table 2-11A lists large reservoirs (500 acre-feet capacity or larger) by highest to lowest maximum storage capacity. Table 2-11B lists other large reservoirs (50 acres or more of surface area) from highest to lowest maximum surface area for those reservoirs for which storage volume was not available.
- Maximum storage information was available for 60 large reservoirs in the basin
- There are 32 large reservoirs for which only surface area data were available.
- 33 large reservoirs are intermittent or dry, particularly those listed in Table 11-B.
- The most common use of large reservoirs is for recreation (46), followed by fire protection, stock or farm use (33) and for irrigation (30).
- More than 40% of the reservoirs serve multiple uses. Two reservoirs, Powell and Blue Ridge are used to generate hydroelectric power.
- The highest concentrations of large reservoirs are in the high elevation areas of the White Mountain and Mogollon Rim, although a number of large reservoirs are located in the drier, lower elevation areas.
- There are 18 large reservoirs on the Navajo reservation and one (for flood control) on the Hopi. Navajo reservation reservoirs are used for the same primary purposes as those in the entire basin. Blue Canyon (#33) reservoir's reported use is for domestic water supply. Water from Lake Powell is treated at Page and delivered to the Navajo community of LeChee.
- Three reservoirs provide municipal water supply to non-reservation communities: Lower Lake Mary (Flagstaff); Powell (Page); and Blue Ridge/C.C. Cragin Reservoir, which is used as a municipal supply outside the basin.
- Capacity information was available for 416 small reservoirs, which have a combined maximum storage capacity of 13,343 acre-feet.
- There are 269 small reservoirs for which only surface area data was available with a total surface area of 3,907 acres.
- Because of the large number of small reservoirs, and less reliable data, individual reservoir data is not provided.
- Stock pond data was compiled from the ADWR surface water registry for ponds with a capacity of 15 acre-feet or less. There are an estimated 6,113 stock ponds in the basin, although this has not been field verified.

Runoff Contour

- Refer to Figure 2-17.
- Runoff contours reflect the average annual runoff in tributary streams. They provide a generalized indication of the amount of runoff that can be expected at a particular geographic location.
- Average annual runoff varies from 5 inches per year at higher elevations along the Mogollon Rim and near Greer to 0.1 inches near the Little Colorado River and along a contour stretching from near Sanders, through Polacca to the northwest corner of the basin.

Table 2-9 Streamflow Data for the Little Colorado River Plateau Basin

Station Number	USGS Station Name	Contributing Drainage Area (in sq. miles)	Mean Basin Elevation (in feet)	Period of Record	Average Seasonal Flow (% of Annual Flow)				Annual Flow in Acre-Feet (Year)				Years of Annual Flow Record
					Winter	Spring	Summer	Fall	Minimum	Median	Mean	Maximum	
9379025	Chinle Creek at Chinle ¹	639	NA	11/1999-current	49	42	6	2	905 (2002)	6,624	6,258	10,860 (2004)	5
9379050	Lukachukai Creek near Lukachukai ¹	Not determined	NA	11/1999-current	28	37	22	13	796 (2002)	1,947	1,781	2,172 (2003)	5
9379180	Laguna Creek at Dennehotso	414	NA	7/1996-current	13	4	61	22	1,694 (2004)	3,826	4,408	8,760 (1997)	6
9379200	Chinle Creek near Mexican Water ¹	3,650	6,260	10/1964-current	19	32	36	13	3,062 (1994)	15,457	20,429	67,692 (1982)	40
9379910	Colorado River below Glen Canyon Dam	107,741	NA	10/1965-9/2003	23	28	27	22	7,847,916 (2002)	8,166,466	8,382,855	9,252,432 (1971)	9
9380000	Colorado River at Lees Ferry ¹	107,841	NA	10/1921-current	16	44	24	16	1,383,521 (1963)	9,375,509	10,885,307	20,322,048 (1984)	83
9383000	Colorado River at Compact Point near Lees Ferry	108,041	NA	10/1980-9/2004	24	25	28	22	7,833,437 (1988)	8,383,659	9,876,067	18,699,615 (1986)	20
9383200	Lee Valley Creek above Lee Valley Reservoir near Greer	1.3	NA	10/1966-9/1972 (discontinued)	7	43	26	24	261 (1970)	398	405	543 (1969)	5
9383220	Lee Valley Creek Tributary near Greer	0.5	NA	10/1966-9/1972 (discontinued)	9	47	30	13	11 (1969)	94	79	130 (1969)	5
9383250	Lee Valley Creek below Lee Valley Reservoir near Greer	1.9	NA	10/1966-9/1972 (discontinued)	17	29	30	24	116 (1967)	188	191	239 (1970)	5
9383400	Little Colorado River at Greer	29.1	9,400	8/1960-9/1982 (discontinued)	12	59	20	9	5,198 (1961)	8,688	11,437	25,267 (1973)	21
9383500	Nutrioso Creek above Nelson Reservoir near Springerville	83.3	8,550	6/1967-9/1982 (discontinued)	21	63	6	10	485 (1977)	2,729	4,517	16,507 (1973)	14
9383550	Nutrioso Creek below Nelson Reservoir near Springerville	86.8	NA	7/1967-9/1982 (discontinued)	19	69	4	8	290 (1977)	2,237	4,235	17,013 (1973)	14
9384000	Little Colorado River above Lyman Lake near St. Johns ¹	704	7,760	4/1940-current	20	52	17	10	2,259 (1996)	11,113	15,588	51,258 (1941)	64
9385500	Little Colorado River below Lyman Reservoir near St. Johns	790	NA	4/1941-9/1985 ²	21	63	6	10	478 (1963)	1,509	2,722	19,547 (1973)	34
9385700	Little Colorado River below Salado Springs ¹	845	NA	3/1985-current	26	52	13	9	2,432 (2003) and 2,164 (2004)				2

Table 2-9 Streamflow Data for the Little Colorado River Plateau Basin

Station Number	USGS Station Name	Contributing Drainage Area (in sq. miles)	Mean Basin Elevation (in feet)	Period of Record	Average Seasonal Flow (% of Annual Flow)				Annual Flow in Acre-Feet (Year)				Years of Annual Flow Record
					Winter	Spring	Summer	Fall	Minimum	Median	Mean	Maximum	
9386000	Little Colorado River at St. Johns	964	NA	4/1906-4/1940 (discontinued)	24	33	27	16	2,013 (1939)	3,895	10,309	45,538 (1909)	8
9386030	Little Colorado River above Zion Reservoir near St. Johns ¹	1,005	NA	10/1975-current	29	31	16	24	94 (2004)	3,453	5,149	18,823 (1985)	29
9386250	Carrizo Wash near St. Johns ¹	Not determined	NA	8/1998-current	0	0	99	1	65 (2004)	1,596	2,082	5,169 (2002)	5
9386300	Little Colorado River below Zion Reservoir near St. Johns	NA	NA	9/1998-current	1	<1	97	2	80 (2003)	116	2,684	11,798 (2002)	6
9386500	Little Colorado River above Zuni Reservoir near Hunt	3,557	7,160	3/1940-9/1972 (discontinued)	16	10	60	14	8 (1961)	2,266	3,778	22,009 (1955)	31
9388000	Little Colorado River near Hunt	6,173	7,060	5/1929-9/1972 (discontinued)	14	12	64	10	239 (1962)	5,046	10,424	58,424 (1941)	34
9390000	Silver Creek near Shumway	119	NA	10/1944-6/1955 (discontinued)	12	44	38	6	5,575 (1951)	7,891	8,466	13,683 (1952)	10
9390500	Show Low Creek near Lakeside ¹	68.6	7,320	5/1953-current	53	19	9	19	970 (2002)	6,863	9,692	31,493 (1978)	51
9392000	Show Low Creek below Jaques Dam near Show Low ¹	73.0	NA	10/1955-current	47	25	13	14	1,405 (1990)	3,033	6,391	28,090 (1993)	49
9392500	Show Low Creek at Show Low	90.2	NA	10/1944-6/1955 (discontinued)	65	12	12	11	1,086 (1953)	4,156	6,519	24,832 (1952)	10
9393400	Cottonwood Wash at Snowflake ¹	262	NA	10/1981-8/1984	79	0	3	17	3,460 (1982) and 10,060 (1983)				2
9393500	Silver Creek near Snowflake	846	6,400	10/1950-9/1995 (discontinued)	45	8	28	19	2,020 (1990)	10,461	13,830	59,583 (1993)	44
9394000	Silver Creek near Woodruff	887	NA	4/1929-9/1952 (discontinued)	51	4	36	9	4,293 (1942)	14,914	17,902	58,642 (1932)	15
9394500	Little Colorado River at Woodruff ¹	7,775	6,810	3/1905-current	27	12	46	15	5,524 (2000)	26,860	35,839	165,791 (1919)	74
9396500	Puerco River near Adamana	2,604	6,730	4/1940-9/1949 (discontinued)	24	13	47	16	9,557 (1944)	26,642	46,732	167,963 (1941)	8
9397000	Little Colorado River at Holbrook ¹	11,115	6,730	3/1905-current	19	10	55	16	13,973 (1950)	82,533	91,138	197,646 (1968)	26
9397500	Chevelon Fork below Wildcat Canyon near Winslow ¹	271	7,030	5/1947-current	57	28	5	10	0 (1996, 2002)	22,950	30,032	97,737 (1965)	30

Table 2-9 Streamflow Data for the Little Colorado River Plateau Basin

Station Number	USGS Station Name	Contributing Drainage Area (in sq. miles)	Mean Basin Elevation (in feet)	Period of Record	Average Seasonal Flow (% of Annual Flow)				Annual Flow in Acre-Feet (Year)				Years of Annual Flow Record
					Winter	Spring	Summer	Fall	Minimum	Median	Mean	Maximum	
9398000	Chevelon Creek near Winslow ¹	781	6,440	1/1906-9/1972 (discontinued, now real-time)	49	33	6	11	10,715 (1956)	32,651	38,756	99,909 (1952)	44
9398500	Cleak Creek below Willow Creek near Winslow	317	7,100	6/1948-9/1991 (discontinued)	41	45	3	11	4,127 (1990)	36,633	59,275	168,963 (1973)	43
9399000	Clear Creek near Winslow ¹	621	6,500	1906-12/1982 (discontinued, now real-time)	39	49	2	9	3,852 (1967)	46,697	60,719	183,890 (1978)	51
9400350	Little Colorado River near Winslow ¹	16,100	NA	12/2001-current	52	9	23	16	54,009 (2003)	69,140	73,870	98,461 (2004)	3
9400562	Oraibi Wash near Tolani Lake ¹	635	NA	7/1995-current	1	0	72	19	434 (1996)	1,998	1,980	4,177 (1997)	9
9400568	Polacca Wash near Second Mesa ¹	905	NA	4/1994-current	5	1	73	21	195 (1995)	2,125	2,117	3,678 (1997)	8
9400583	Jeddito Wash near Jeddito ¹	147	NA	9/1993-current	0	1	88	11	14 (1998)	145	298	1,426 (2003)	11
9401000	Little Colorado River at Grand Falls	20,700	6,440	11/1925-9/1994 (discontinued)	39	24	30	7	18,461 (1956)	162,171	198,406	587,869 (1941)	24
9401110	Dinnebito Wash near Sand Springs ¹	473	NA	6/1993-current	5	3	78	14	311 (1994)	2,085	2,680	6,682 (2004)	11
9401226	Coal Mine Wash Tributary near Kayenta	0.6	NA	10/1977-9/1981 (discontinued)	2	4	90	4	0 (1979)	3	24	70 (1980)	3
9401239	Coal Mine Wash near Mouth near Shonto	NA	NA	5/1978-10/1982 (discontinued)	20	11	48	21	434 (1979)	775	857	1,361 (1980)	3
9401260	Moenkopi Wash at Moenkopi ¹	1,629	5,850	7/1976-current	13	4	64	18	1,376 (1994)	7,457	7,083	14,769 (2001)	28
9401280	Moenkopi Wash near Tuba City	1,904	NA	7/1926-9/1940 (discontinued)	8	2	81	9	5,408 (1928)	9,774	16,334	45,828 (1930)	13
9401400	Moenkopi Wash near Tuba City	2,492	5,820	10/1940-9/1978 (discontinued)	8	2	58	33	2,179 (1944)	8,833	11,158	44,452 (1972)	25

Sources: USGS NWIS, USGS 1998 and USGS 2003.

Notes:

NA = Not available to ADWR

Statistics based on Calendar Year

Average Seasonal Flow statistics based on monthly values

Summation of Average Annual Flows may not equal 100 due to rounding.

Period of Record may not equal Years of Annual Flow Record used for annual Flow/Year statistics due to only using years with a 12 month record

Table 2-9 Streamflow Data for the Little Colorado River Plateau Basin

Station Number	USGS Station Name	Contributing Drainage Area (in sq. miles)	Mean Basin Elevation (in feet)	Period of Record	Average Seasonal Flow (% of Annual Flow)				Annual Flow in Acre-Feet (Year)				Years of Annual Flow Record
					Winter	Spring	Summer	Fall	Minimum	Median	Mean	Maximum	

In Period of Record, current equals September 2005

¹Real-time gage

²Station operated by SRP after 1985 and table statistics do not include the SRP data

Table 2-10 Flood Alert Equipment in the Little Colorado River Plateau Basin

Station ID	Station Name	Station Type	Install Date	Responsibility
1701	Little Colorado River @ Hunt	Precipitation/Stage	NA	Navajo County FCD
1715	Black Canyon Lake	Precipitation/Stage	NA	Navajo County FCD
1720	Oklahoma Flat	Precipitation	NA	Navajo County FCD
1722	Stermer Ridge	Precipitation	NA	Navajo County FCD
1724	Bunger Point	Precipitation	NA	Navajo County FCD
1725	Dreamy Draw	Precipitation/Stage	3/1/2004	Navajo County FCD
1729	Little Colorado River @ Winslow @I-40	Precipitation/Stage	10/27/1995	Navajo County FCD
1739	Cottonwood Wash - Winslow	Stage	NA	Navajo County FCD
1743	Obed Bridge over Little Colorado River @ Joseph City	Precipitation/Stage	9/5/1995	Navajo County FCD
1750	Leroux Wash	Precipitation/Stage	11/2/1995	Navajo County FCD
1764	Little Colorado River @ Holbrook	Precipitation/Stage	NA	Navajo County FCD
1771	Joseph City @ SR 66	Precipitation/Stage	NA	Navajo County FCD
1778	Pinedale Ridge	Precipitation	8/1/2001	Navajo County FCD
1785	Silver Creek at Snowflake	Precipitation/Stage	8/1/2001	Navajo County FCD
1795	Lone Pine Dam	Precipitation/Stage	8/1/2001	Navajo County FCD
1800	Chevelon Butte 20 mi. SW of Winslow	Repeater/Precipitation	7/18/1995	Navajo County FCD
1804	Porter Mountain	Repeater/Precipitation	1/18/1995	Navajo County FCD
1808	Buckskin Wash	Precipitation/Stage	NA	Navajo County FCD
1815	Schoens Dam	Precipitation/Stage	8/1/2001	Navajo County FCD

Table 2-10 Flood Alert Equipment in the Little Colorado River Plateau Basin

Station ID	Station Name	Station Type	Install Date	Responsibility
1822	White Mountain Lake	Precipitation/Stage	NA	Navajo County FCD
1829	Cottonwood Wash - Taylor	Precipitation/Stage	10/6/1995	Navajo County FCD
1843	Dutch Joe	Precipitation	8/1/2001	Navajo County FCD
1850	Morgan Wash	Precipitation/Stage	11/22/1995	Navajo County FCD
1857	Holbrook Base Station	Precipitation	NA	Navajo County FCD
1864	South County Complex	Precipitation	NA	Navajo County FCD
1871	Heber Repeater	Repeater/Precipitation	NA	Navajo County FCD
1881	Black Canyon Wash	Stage	NA	Navajo County FCD
1885	Heber SNOTEL	Precipitation	NA	Navajo County FCD
1892	Show Low Lake	Precipitation	NA	Navajo County FCD
1893	Phoenix Park Wash	Precipitation/Stage	NA	Navajo County FCD
3300	Newman Canyon	Precipitation/Stage	NA	City of Flagstaff
3310	Rio de Flag	Precipitation/Stage	NA	City of Flagstaff

FCD = Flood Control District

NA = Not available to ADWR

Table 2-11 Reservoirs and Stock Ponds in the Little Colorado River Plateau Basin

A. Large Reservoirs (500 acre-feet capacity and greater)

MAP KEY	RESERVOIR/LAKE NAME (Name of dam, if different)	OWNER/OPERATOR	MAXIMUM STORAGE (AF)	USE ¹	JURISDICTION
1	Powell (Glen Canyon Dam)	Bureau of Reclamation	20,325,000	H,I,O,R,S	Federal
2	Schoens	Navajo County	62,000	C	State
3	Lyman	Lyman Water Co	44,500	I,R	State
4	Many Farms	Navajo Nation	32,500	I,R	Tribal
5	Upper Lake Mary	City of Flagstaff	21,041	S,R	State
6	Red ²	Navajo Nation	15,517	F,I,R	Tribal
7	Blue Ridge/C.C. Cragin	Bureau of Reclamation/Salt River Project	15,000	H,S,R	State
8	Mormon	Coconino NF	15,000	F,R	Federal
9	Lone Pine ³	Navajo County	14,700	C	State
10	White Mountain (Daggs Dam)	Snowflake & Taylor Irrigation	13,750	I,R	State
11	Tremaine (Hay Lake Dam)	Bar T Bar Ranch	9,000	I	State
12	Chevelon Canyon	AZ Game & Fish	8,542	R	State
13	Show Low (Jacques Dam)	City of Show Low	8,160	O,R	State
14	Tsaile	Navajo Nation	8,100	I,R	Tribal
15	Wheatfields	Navajo Nation	5,700	I,R	Tribal
16	Fool's Hollow	AZ Game & Fish	5,617	R	State
17	Canyon Diablo Reservoir	Navajo Nation	4,700	I,R	Tribal
18	Willow Springs	AZ Game & Fish	4,230	R	State
19	Ashurst	AZ Game & Fish	4,164	R	State
20	Alejandro	Private	4,111	U	State
21	Ganado Reservoir	Navajo Nation	3,750	I,R	Tribal
22	Dry Lake II (Twin Lakes Dam)	Abitibi	3,700 ⁴	O	State
23	Hay ³	Bar T Bar Ranch	3,530	U	State
24	River Reservoir	Round Valley Water Users	3,195	I,R	State
25	Kinnikinick	AZ Game & Fish	3,124	R	State
26	Ortega + Little Ortega (Ortega Lake Retention)	Silver Creek Flood Control	2,500	C,R	State
27	White Mountain	Round Valley Water Users	2,391 ⁴	I,R	State
28	Lower Lake Mary	Coconino NF	2,240	R,S	Federal
29	Rainbow (Lakeside Dam)	Show Low Irrigation	2,226	I,R	State
30	Cholla	Arizona Public Service	2,200 ⁴	F,O,R	State
31	Millett Swale	Silver Creek Flood Control	2,104	C	State
32	Black Canyon	AZ Game & Fish	1,900	R	State
33	Blue Canyon	Navajo Nation	1,900	S	Tribal
34	Soldier Annex	Coconino NF	1,886	F,I,P,R	Federal
35	Knoll	AZ Game & Fish	1,774	R	State
36	Scott Reservoir	Show Low Irrigation	1,740	I,R	State
37	Bear Canyon	AZ Game & Fish	1,638	R	State
38	Concho	Concho Water Co	1,560	I,R	State
39	Unnamed (Twin Dams)	Hopi Tribe	1,500	C	Tribal
40	Little Mormon	Apache Sitgreaves NF	1,400	F,R	Federal
41	Becker	Apache Sitgreaves NF	1,338	I,F,R	Federal
42	Woods Canyon	AZ Game & Fish	1,232	R	State
43	Little	St. John's Irrigation	1,200 ⁴	I,R	State
44	Long ³	Apache Sitgreaves NF	1,200	F,R	Federal
45	Mexican ³	Apache Sitgreaves NF	1,100	C,F,I	Federal
46	Round Rock	Navajo Nation	1,070	I,R	Tribal
47	Hog Wallow	Lyman Water Co	1,000	I	State
48	Pool Corral	Lyman Water Co	993	I	State
49	Nelson	AZ Game & Fish	900	R	State
50	Slade	Private	898	I	State
51	Broken Tank	AZ State Land Dept.	851 ⁴	P	State
52	Mexican Hay	Lyman Water Co	821	I,R	State
53	Clear Creek (Clear Creek #2)	City of Winslow	750	I,R	State
54	Tunnel	Apache Sitgreaves NF	694	I,R	Federal
55	Norton ³	Town of Springerville	680	I	State
56	Haumont Tank ³	AZ State Land Dept./Rancho Allegra	674	I	State
57	Lee Valley	AZ Game & Fish	640	I,R	State
58	Soldiers	Coconino NF	550	R	Federal
59	Patterson	AZ Land Dept	534 ⁴	P	State
60	Bunch	Round Valley Water Users	512	I,R	State

Table 2-11 Reservoirs and Stock Ponds in the Little Colorado River Plateau Basin

B. Other Large Reservoirs (50 acre surface area or greater)⁵

MAP KEY	RESERVOIR/LAKE NAME	OWNER/OPERATOR	MAXIMUM SURFACE AREA (acres)	USE ¹	JURISDICTION
61	Dry ⁶	Navajo Nation	2,642	P	Tribal
62	Dry ⁶	Private	1,817	P	Landowner
63	Dry	Private	1,674	P	Landowner
64	Red ⁶	Navajo Nation	502	P	Tribal
65	Ortega Sink ⁶	Apache Sitgreaves NF	405	P	Federal
66	Long ³	Coconino NF	323	F,P,R	Federal
67	Long	Coconino NF	271	F,P	Federal
68	Greasewood ⁶	Navajo Nation	269	P	Tribal
69	Dry ⁶	Private	215	P	Landowner
70	Mud ⁶	Private	168	F,P	Landowner
71	Tolani ³	Navajo Nation	129	P	Tribal
72	Toh De Niihe ³	Navajo Nation	121	P	Tribal
73	Dry ⁶	Navajo Nation	112	P	Landowner
74	Dry ⁶	Navajo Nation	110	P	Landowner
75	Mud Lake & Tank ³	Coconino NF	106	F,P	Landowner
76	Breezy ³	Coconino NF	101	P,R	Landowner
77	Yaeger Lake & Tank ³	Coconino NF	96	P	Landowner
78	Dry ⁶	Navajo Nation	95	P	Landowner
79	Dry Lake & Windy Tank ⁶	Navajo Nation	92	P	Landowner
80	Unnamed ⁶	Private	90	P	Landowner
81	Vail	Coconino NF	88	P	Federal
82	Grass Flat Tank ³	Coconino NF	88	P	Federal
83	Dry	Navajo Nation	87	P	Tribal
84	Horse Lake & Tank ³	Coconino NF	84	P	Federal
85	Unnamed ³	Private	81	P	Landowner
86	Whipple ³	Apache Sitgreaves NF	75	F,P,R	Federal
87	McDermitt ³	Private	72	P	Landowner
88	Pine Lake & Tank ³	Coconino NF	70	P	Federal
89	Tobenayoli Pond ³	Navajo Nation	65	P	Tribal
90	Deep ³	Coconino NF	62	F	Federal
91	Indian ³	Coconino NF	60	P	Federal
92	To Kla Dua Aakee	Navajo Nation	54	P	Tribal

C. Small Reservoirs (greater than 15 acre-feet and less than 500 acre-feet capacity)

Total number: 416

Total maximum storage: 13,343 acre-feet

D. Other Small Reservoirs (between 5 and 50 acres surface area)⁵

Total number: 269

Total surface area: 3,907 acres

E. Stock Ponds (up to 15 acre-feet capacity)

Total number: 6,113 (estimate based on water right filings)

Notes:

NF = National Forest

¹C=flood control; F=fish & wildlife pond; H=hydroelectric; I=irrigation; N= navigation; O=other; P=fire protection, stock or farm pond

R=recreation; S=water supply; U=unknown

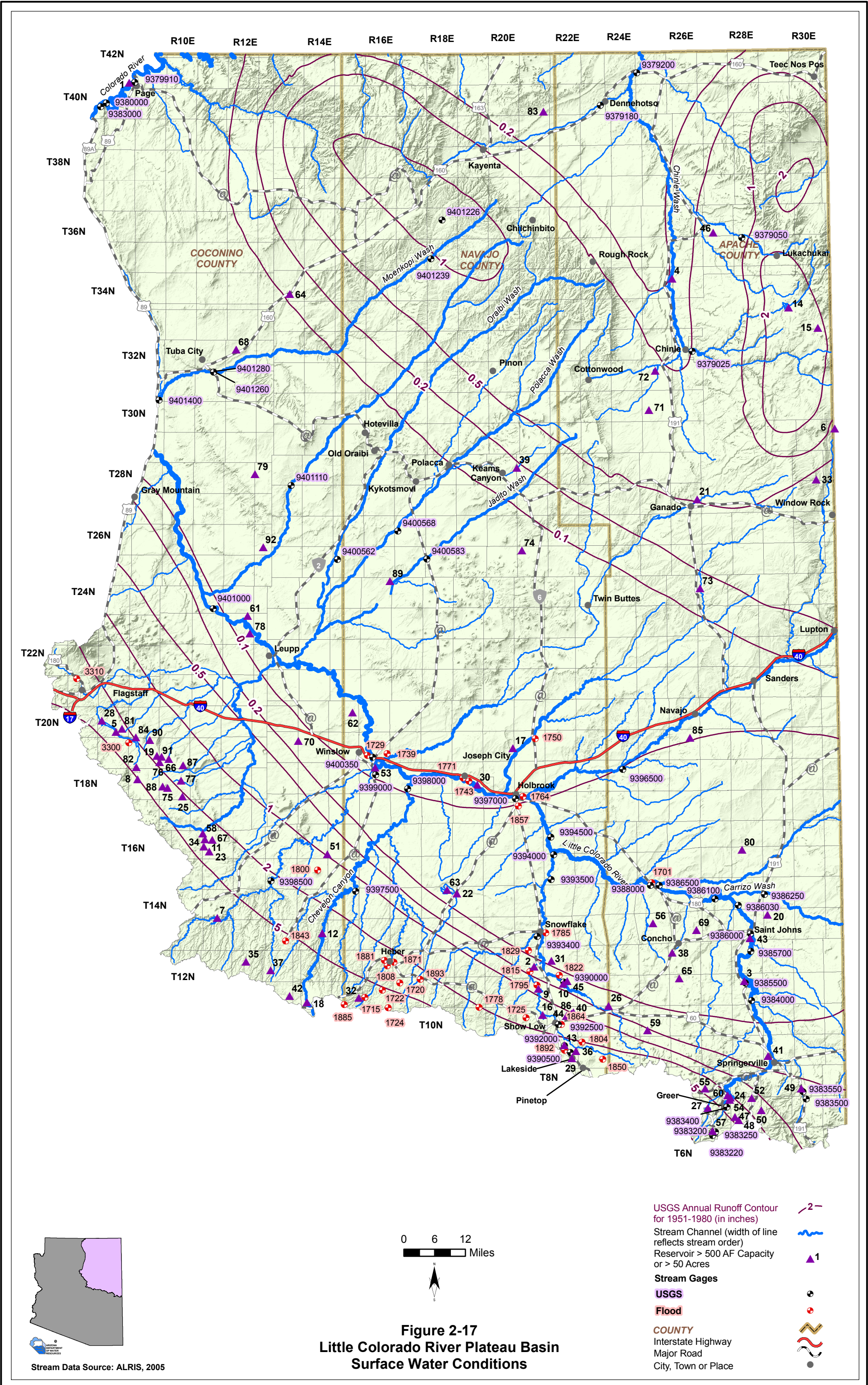
²Dam is in New Mexico as is most of the lake

³Intermittent Lake

⁴Normal capacity < 500 acre-feet

⁵Capacity data not available to ADWR

⁶Dry Lake



2.1.5 Perennial/Intermittent Streams and Major Springs in the Little Colorado River Plateau Basin

Major and minor springs with discharge rates and date of measurement, and the total number of springs in the basin are shown in Table 2-12. The location of major springs is shown on Figure 2-18, keyed to Table 2-12A. A description of data sources and methods for intermittent and perennial reaches is found in Volume 1, Section 1.3.16. A description of spring data sources and methods is found in Volume 1, Section 1.3.14.

- Perennial streams are found at higher elevations in the basin due to winter snow and monsoon storms and where supported by spring flow. The Little Colorado River, the major drainage in the basin, flows perennially only in areas near the headwaters and below Silver Creek.
- An intermittent stream GIS cover was unavailable for tribal lands.
- There are 37 “major” springs with a measured discharge of 10 gallons per minute (gpm) or greater at any time.
- Listed discharge rates may not be indicative of current conditions. Many of the measurements were taken prior to 1990. Only 6 major and 6 minor spring measurements post-date 1990.
- Greatest discharge rates were measured in the far southeastern corner of the basin at the headwaters of Silver Creek (Silver, 3,648 gpm), south of Saint Johns (Salado, 1,730 gpm), east of Pinetop (Big, 1,211 gpm) and near Concho (Concho, 1,120 gpm). Most of the other major springs are also located in this area. A cluster of major springs is also located in the vicinity of Tuba City and the Hopi community of Moenkopi.
- Almost three quarters of the major springs discharge less than 100 gpm.
- Springs with measured discharge of 1 to 10 gpm are not mapped but coordinates are given in Table 2-12B. There are 50 “minor” springs identified in the basin.
- The total number of springs identified by the USGS varies between 1,222 to 1,305, depending on the database reference.

Table 2-12 Springs in the Little Colorado River Plateau Basin

A. Major Springs (10 gpm or greater):

Map Key	Name	Location		Discharge (in gpm) ¹	Date Discharge Measured
		Latitude	Longitude		
1	Silver	341951	1095527	3,648	06/1990
2	Salado	342604	1092352	1,730	On or before 1990
3	Big (multiple)	340814	1095804	1,211	11/30/1990
4	Concho	342551	1093745	1,120	12/6/1951
5	Pinetop	340724	1095454	673	11/20/1990
6	Carnero	340609	1093212	400	9/24/1974
7	Adair	340825	1095727	276	11/30/1990
8	Unnamed ²	342240	1092318	200	8/15/1985
9	Porter/Paige	341047	1095622	145	7/1/1971
10	Moenave	360840	1112005	118	2/25/1948
11	Wiltbank	341629	1092359	100	1/6/1975
12	Bourdon Ranch	342039	1095612	100	6/25/1952
13	Big Hollow Wash	343215	1092520	67	9/17/1975
14	Dotson Upper	360830	1111441	66	7/26/1954
15	Sheep	340316	1093358	60	5/22/1952
16	Unnamed	343135	1092553	50	2/12/1975
17	Sawmill	345014	1112234	40	7/18/1978
18	Whitcom	340845	1095217	40	6/11/1952
19	Danstone	340921	1094749	38	6/13/1952
20	Unnamed ²	342251	1092251	37	8/15/1985
21	Unnamed	342247	1092254	31	8/15/1985
22	Pasture Canyon ²	361021	1111159	31	4/26/2004
23	Davis ²	342932	1091634	29	1/1/1957
24	Big Leroux's	351736	1114327	25	9/26/1949
25	Los Burros	340829	1094634	25	6/11/1952
26	24 Ranch	341723	1092445	20	1/6/1975
27	Oak	351438	1113521	20	9/20/1962
28	Thompson	340752	1095358	20	6/11/1952
29	Dotson Lower	360828	1111441	19	7/26/1954
30	Charlie Day	360833	1111412	16	6/10/1988
31	Hoxworth	350225	1113427	15	4/1/1996
32	Wide Reeds Ruins (right)	354237	1093312	15	11/9/2004
33	Unnamed Near Dennehotso	364656	1094254	13	04/2004
34	Moenkopi School	360632	1111311	12	3/29/2004
35	Wide Reeds Ruins (left)	354237	1093312	11	11/9/2004
36	Mineral	340939	1093645	10	11/20/1974
37	Schuster	342859	1093002	10	2/6/1975

Table 2-12 Springs in the Little Colorado River Plateau Basin

B. Minor Springs (1 to 10 gpm):

Name	Location		Discharge (in gpm) ¹	Date Discharge Measured
	Latitude	Longitude		
Little Giant	341027	1093417	8	9/24/1974
Atascacita	341007	1093100	8	9/24/1974
Neilson	341753	1092124	8	1/17/1975
Huse	354218	1144836	7	2/10/1976
CC Hall	340715	1093737	6	6/23/1952
Mud	342154	1092847	5	1/7/1975
Ortega	342657	1093555	5	1/15/1975
McIntosh	343048	1091740	5	7/1/1946
Navajo	350605	1092938	5	11/18/1975
Halleck ²	340730	1095513	5	06/1952
Walker Wash	361056	1141732	5	3/12/1980
Unnamed	351823	1114243	5	8/23/1979
Chipmunk	340830	1095218	4	6/11/1952
Malpais	342428	1093325	4	1/15/1975
Ashurst	350131	1112949	3	7/26/1978
Bitter	363930	1113845	3	4/30/1952
Red Bluff (south)	362740	1141512	3	3/11/1980
Unnamed	340913	1092742	3	12/24/1974
Hall	341624	1092055	3	1/16/1975
Wepo (south)	355325	1102203	3	8/17/1993
Betatakin	364049	1103218	3	8/28/2002
Hotevilla	355544	1104024	3	8/16/1993
Laguna Salada	342018	1094324	3	1/15/1975
Babbitt	350401	1113216	2	3/27/2004
Unnamed	362812	1105902	2	7/8/1954
Maynard	361544	1141818	2	3/11/1980
Lizard Hill	350659	1103153	2	7/20/1972
Telephone	340842	1094837	2	6/13/1952
Fireman Cabin	340653	1093736	2	9/24/1974
Unnamed	364128	1103606	2	8/7/1954
Franey	340718	1093744	2	9/24/1974
Unnamed	363632	1103822	2	8/6/1954
Wepo (north)	355330	1102159	2	8/17/1993
Unnamed	342448	1093109	2	1/15/1975
Youngs	350517	1112838	2	7/24/1978
Nasjo Toh	363504	1100937	1	10/13/1954
Unnamed	361603	1105911	1	6/24/1954
Red Bluff (north)	362744	1141505	1	3/11/1980
Beehive	340404	1093239	1	9/23/1974
Sherwood	341715	1092115	1	1/16/1975
Clark	350402	1113444	1	3/27/2004
Salt Seeps	350625	1092706	1	11/18/1975
Coyote	351358	1113934	1	8/27/1979

Table 2-12 Springs in the Little Colorado River Plateau Basin

B. Minor Springs (con't.):

Name	Location		Discharge (in gpm) ¹	Date Discharge Measured
	Latitude	Longitude		
Trough	341937	1102448	1	11/7/1952
McCormick	340853	1094623	1	6/13/1952
Campbell	344453	1112947	1	8/6/2002
Heiser	353021	1112114	1	5/30/2002
Unnamed	362208	1094113	1 ³	11/1/1929
Unnamed ^{2,4}	351521	1113544	1	8/27/1949
Wupatki	353118	1112231	1 ³	8/23/1950

**C. Total number of springs, regardless of discharge, identified by USGS (see ALRIS, 2005 and NHD, 2006):
1,222 to 1,305**

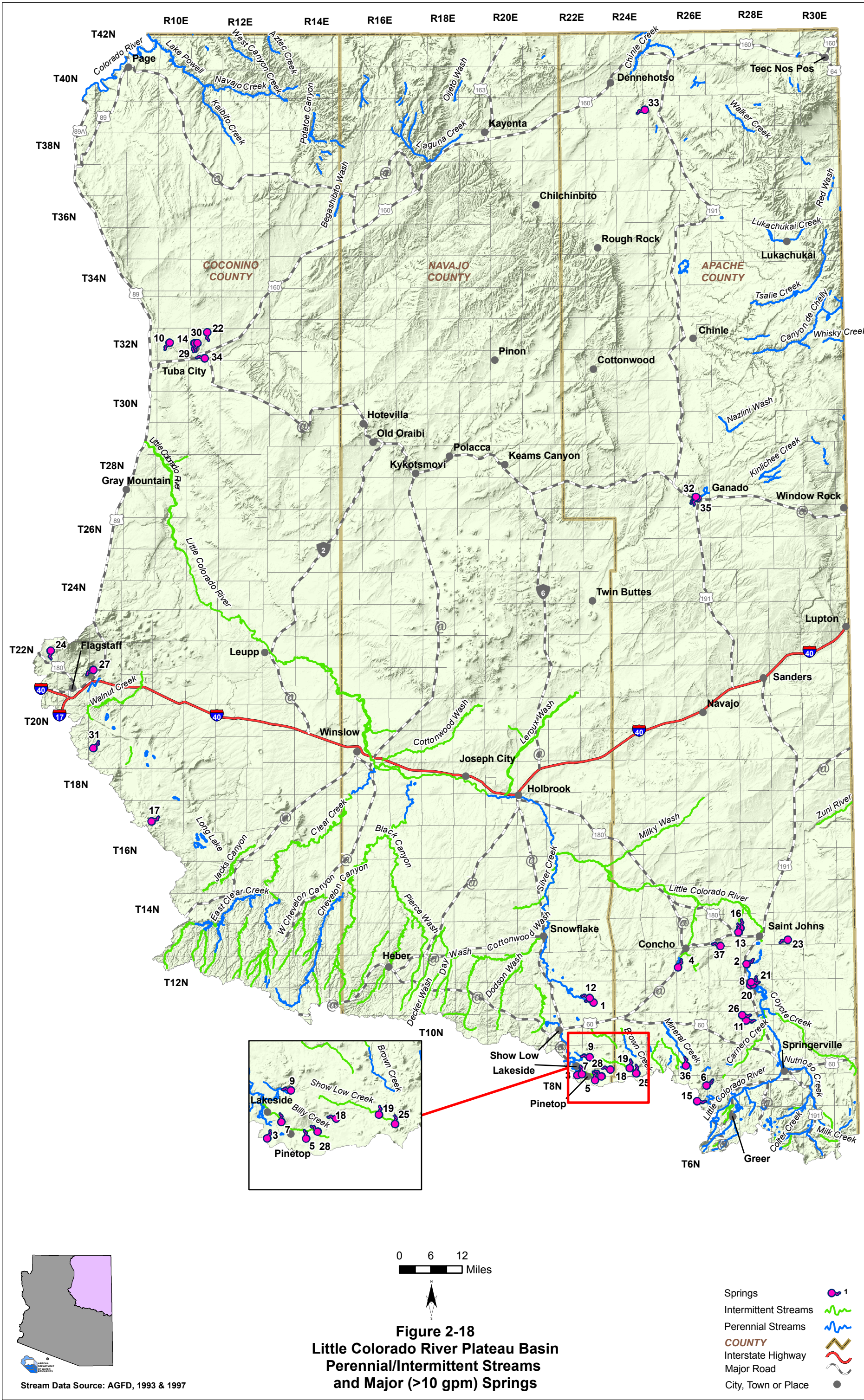
Notes:

¹Most recent measurement identified by ADWR

²Spring not displayed on current USGS topo maps

³Most recent measurement < 1gpm

⁴Location approximated by ADWR



2.1.6 Groundwater Conditions of the Little Colorado River Plateau Basin

Major aquifers, well yields, estimated natural recharge, estimated water in storage, number of index wells and date of last water-level sweep are shown in Table 2-13. Figure 2-19 shows aquifer boundaries, aquifer flow direction and water-level change between 1990-1991 and 2003-2004. Figure 2-20 contains hydrographs for selected wells shown on Figure 2-19. Figure 2-19 shows well yields in 5 yield categories. A description of aquifer data sources and methods is found in Volume 1, Section 1.3.2. A description of well data sources and methods, including water-level changes and well yields is found in Volume 1, Section 1.3.19.

Major Aquifers

- Refer to Table 2-13 and Figure 2-19.
- Major aquifers, their utilization, extent and other characteristics are described in Section 2.0.2. There are several local aquifers and 3 large regional aquifers in the basin.
- Recent stream alluvium aquifers include alluvial deposits along washes and stream channels, including along the Little Colorado River and its tributaries.
- Volcanic aquifers include the Lakeside-Pinetop aquifer and the smaller aquifer inside the caldera of the San Francisco Peaks, known as the “Inner Basin”.
- The large regional aquifers are located in sedimentary formations of sandstone and limestone that are stacked on top of one another and are generally separated by impermeable shales and siltstones. In descending order, the regional aquifers are the D-, N-, and C-aquifers.
- The Bidahochi formation forms a local aquifer in the central part of Apache and Navajo Counties and near St. Johns.
- Undifferentiated sandstones west of Show Low along the Mogollon Rim and in the Springerville-Eager area form local aquifers, known as the White Mountain and Springerville Aquifers, respectively.
- Flow directions are shown in Figure 2-19. Flow directions in the D-aquifer are generally from east to west. Flow in the N-aquifer varies as shown on the map. Flow direction in the C-aquifer is south to north in the southern part of the basin and generally from east to west in the northern part of the basin. The Bidahochi Aquifer flows are not mapped in the area south of Keams Canyon. Flows in the “Volcanic” aquifer are generally toward the north.

Well Yields

- Refer to Table 2-13 and Figure 2-21.
- Well yield information is generally measured when the well is drilled and reported on completion reports. Reported well yields are only a general indicator of aquifer productivity. Specific information is available from well measurements conducted as part of basin investigations.
- Yields vary greatly in the basin. In general, well yields are greatest along the Little Colorado River and in alluvial areas north of Springerville and in the vicinity of Concho, Saint Johns and Snowflake. Areas of lower yield are found in the northern part of the basin and in the volcanic aquifers around Flagstaff and Greer.

Natural Recharge

- Refer to Table 2-13
- Estimates of natural recharge for the large regional aquifers are from relatively recent estimates from USGS studies.
- Estimated natural recharge to the major regional aquifers is 173,820 acre-feet per year to the C-aquifer (areal extent 21,655 square miles), 5,392 acre-feet per year to the D-aquifer (areal extent 3,125 square miles) and between 2,500 to 4,800 acre-feet to the N-aquifer (areal extent 6,250 square miles). Main recharge areas are along the southern and eastern periphery of the basin.
- Recharge rates to other basin aquifers is not known.

Water in Storage

- Refer to Table 2-13
- Estimates of storage are based on rough estimates and considerably more studies are needed. Components of storage include aquifer depth and specific yield.
- The only storage estimate for the entire basin is 508 million acre-feet from a 1989 ADWR study.

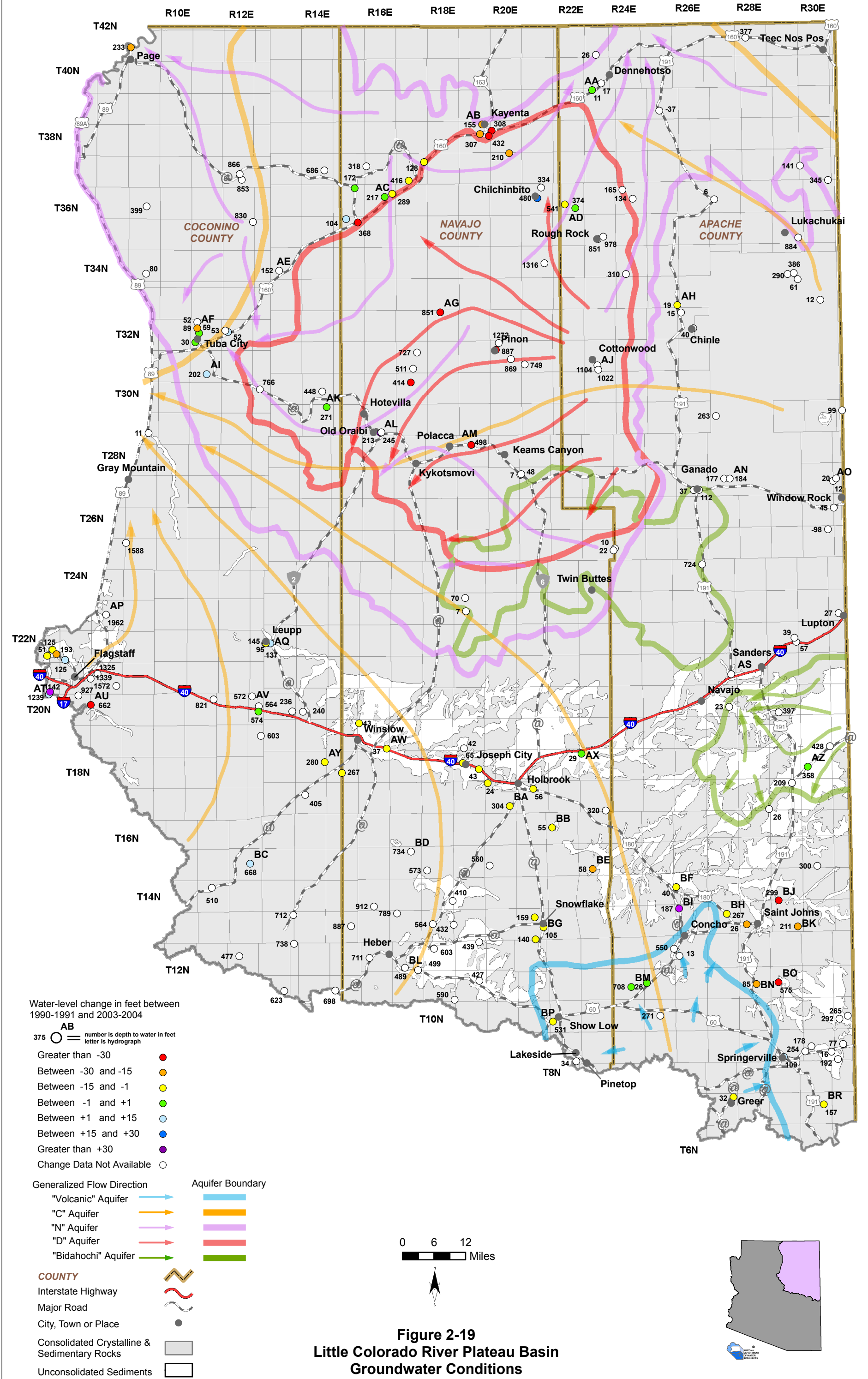
Water Level

- Refer to Figure 2-19
- Depth to water and water-level change between 1990-1991 and 2003-2004 is shown in Figure 2-19. ADWR annually measures 57 index wells in the basin. In 2001, the year of the last water-level sweep in the basin, 932 wells were measured.
- Deep water levels are found in areas near Flagstaff where water levels as deep as 1,572 feet below land surface were measured and near Cottonwood and Pinon. Shallow water levels (<50 feet below land surface) are found along the Little Colorado River, in the Tuba City area, near Window Rock and near Dennehotso.
- Water levels can vary significantly even where wells are in close proximity based on the specific location of the well.
- Areas of most significant decline were found in the vicinity of St. Johns, Pinon, Flagstaff and Kayenta. Few wells measured showed water level rises of more than a foot. Rises were noted in individual wells near Springerville, Concho, Chilchinbito and Flagstaff.
- Hydrographs corresponding to selected wells shown on Figure 2-19 but covering a longer time period are shown in Figure 2-20. Hydrographs show the well depth, the aquifer, the well use and location identifier. Wells located off reservation have a cadastral location code.

Table 2-13 Groundwater Data for the Little Colorado River Plateau Basin

Basin Area, in square miles:	26,700	
Major Aquifer(s):	Geologic Units and/or Name	
	Recent Stream Alluvium	
	Volcanic Rock (Lakeside-Pinetop Aquifer)	
	Sedimentary Rock (Bidahochi Formation, C, D, N, Springerville, and White Mountain Aquifers)	
Well Yields, in gal/min:	Range 8-1,602 Median 95 (85 wells measured)	Measured by ADWR and/or USGS or NTUA ¹
	Range 1-3,000 Median 500 (386 wells reported)	Reported on registration forms for large (> 10-inch) diameter wells
	Range 30-300	ADWR (1990)
	Range 0-2,500	USGS (1994)
Estimated Natural Recharge, in acre-feet/year:	173,820 (C Aquifer)	USGS (2002)
	5,392 (D Aquifer)	USGS (2003)
	>2,500 - >4,800 (N Aquifer)	USGS (1996)
Estimated Water Currently in Storage, in acre-feet:	508,000,000 (total)	ADWR (1990)
	413,000,000 (C Aquifer)	ADWR (1989)
	15,000,000 (D Aquifer)	ADWR (1989)
	166,000,000 - 293,400,000 (N Aquifer)	ADWR (1989) and USGS (1996)
	N/A	Freethy and Anderson (1986)
	N/A	Arizona Water Commission (1975)
Current Number of Index Wells:	57	
Date of Last Water-level Sweep:	2001 (932 wells measured)	

¹NTUA = Navajo Tribal Utility Authority



**Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells**

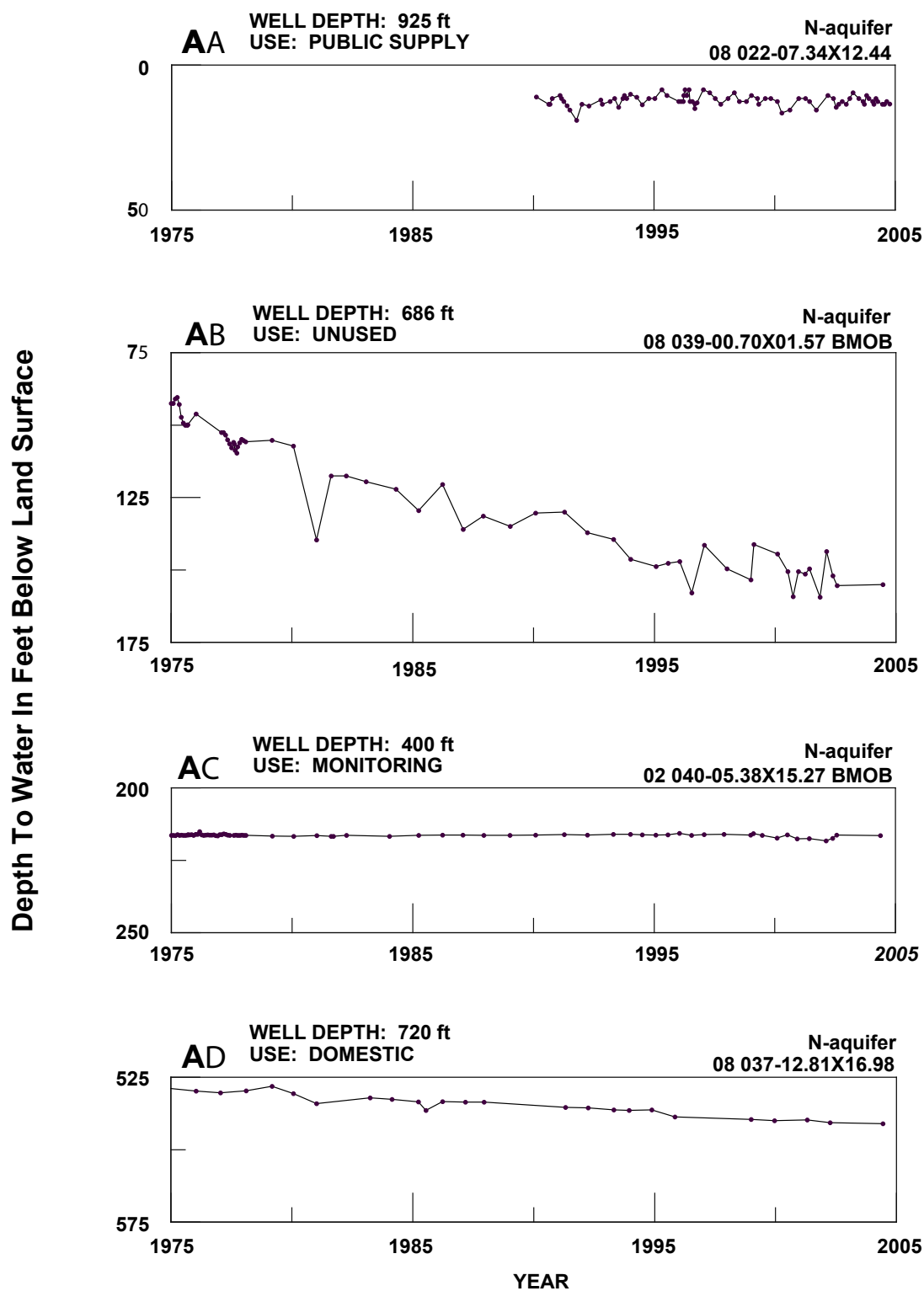


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

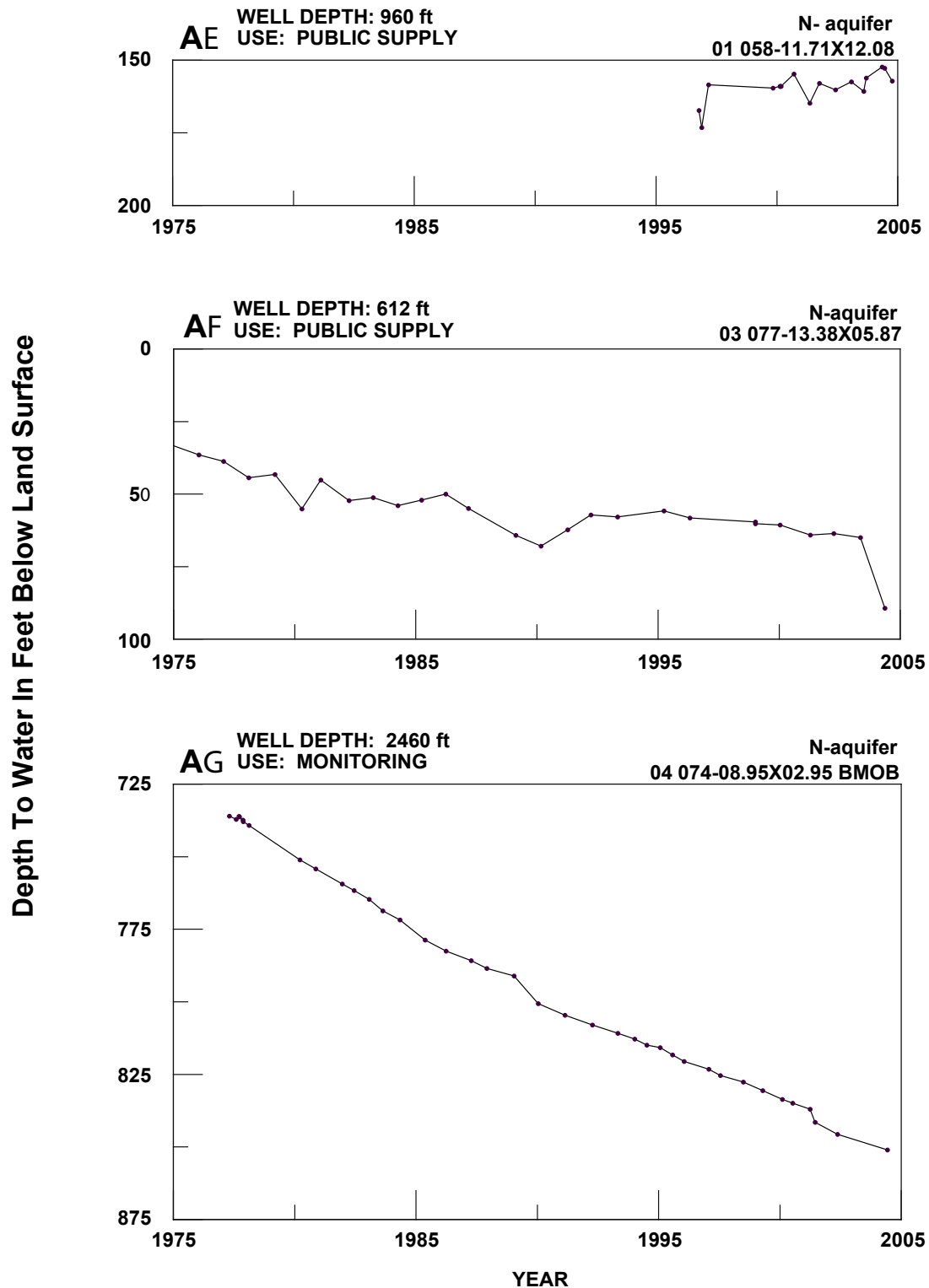


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

Depth To Water In Feet Below Land Surface

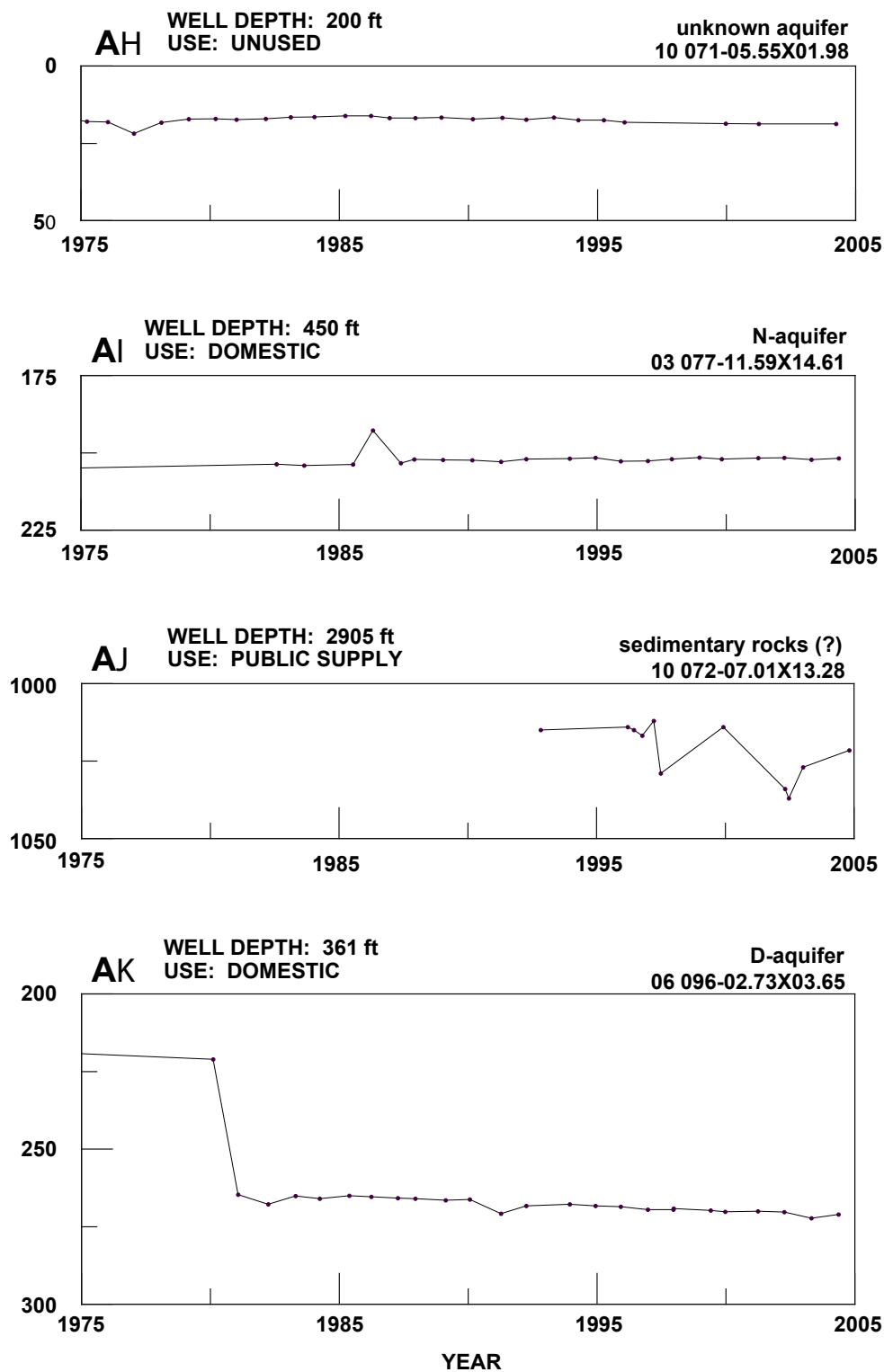


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

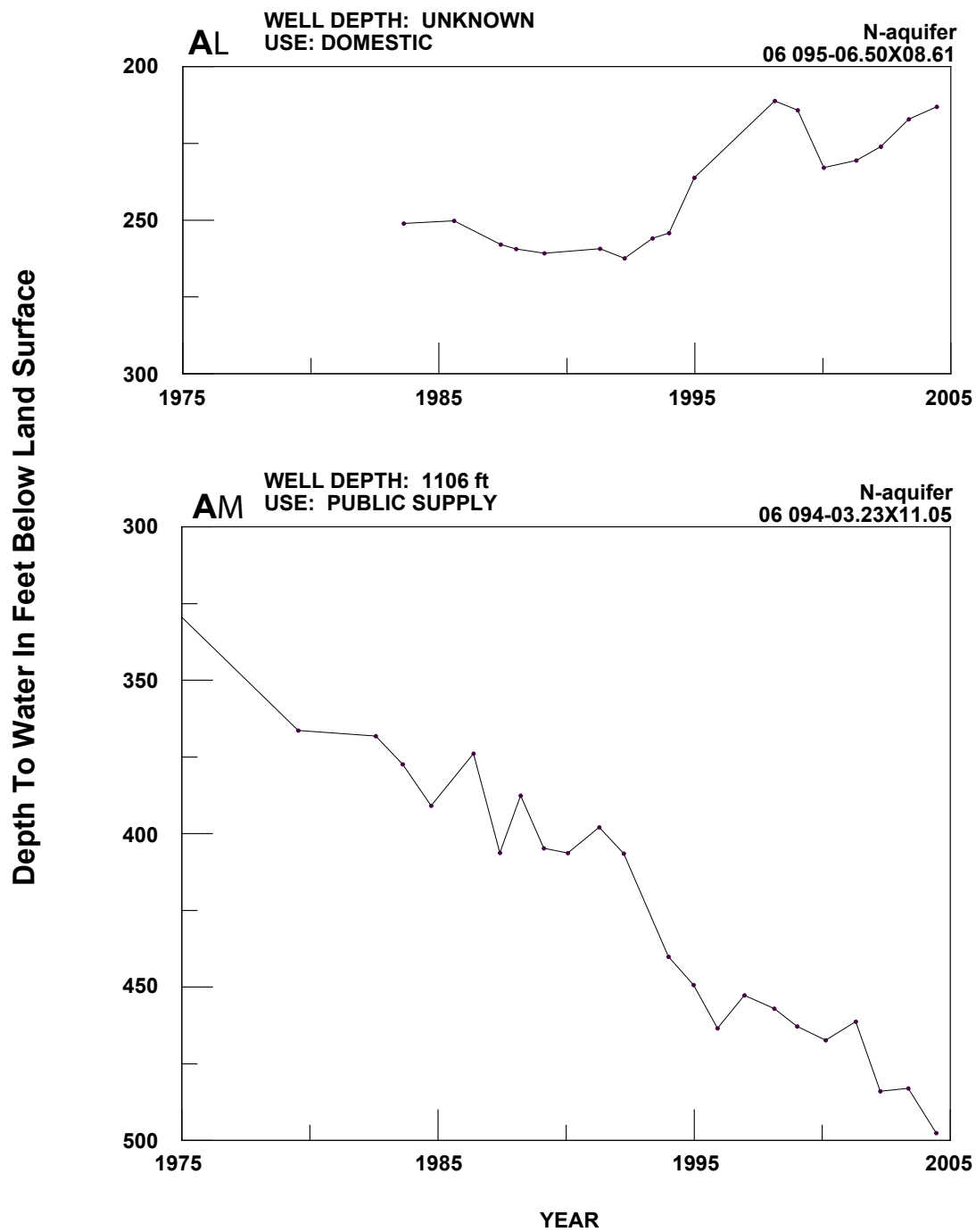


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

Depth To Water In Feet Below Land Surface

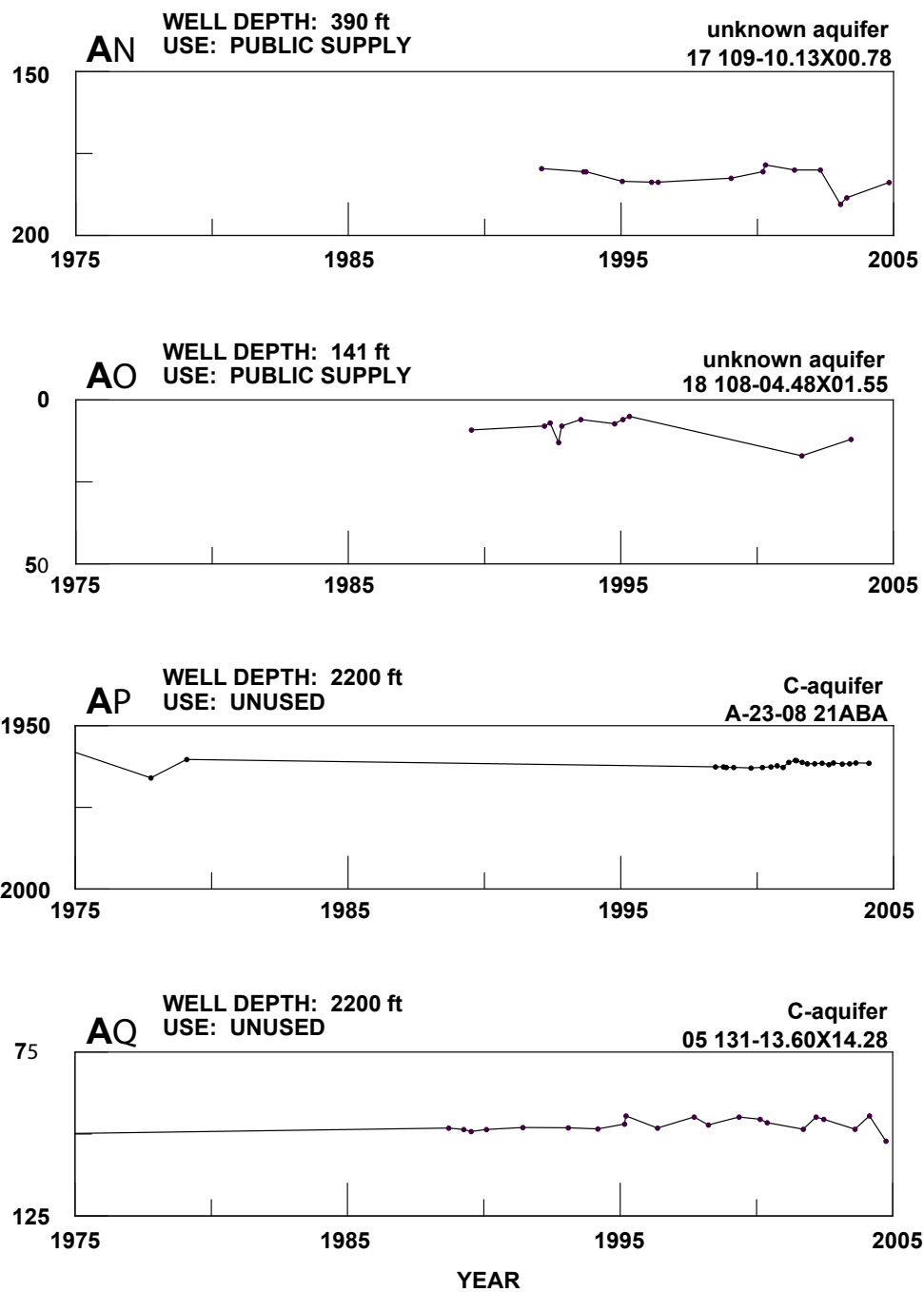


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

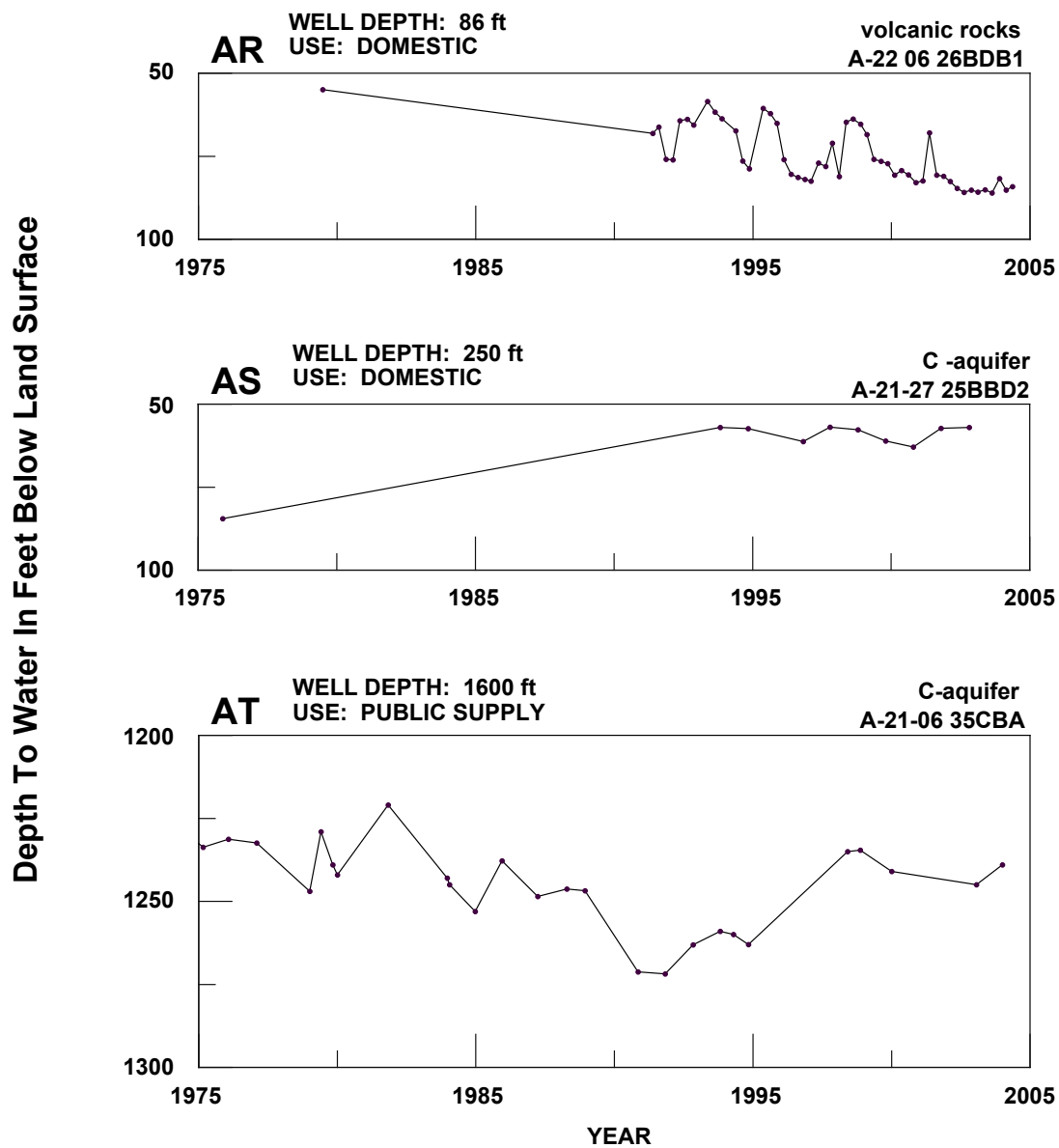


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

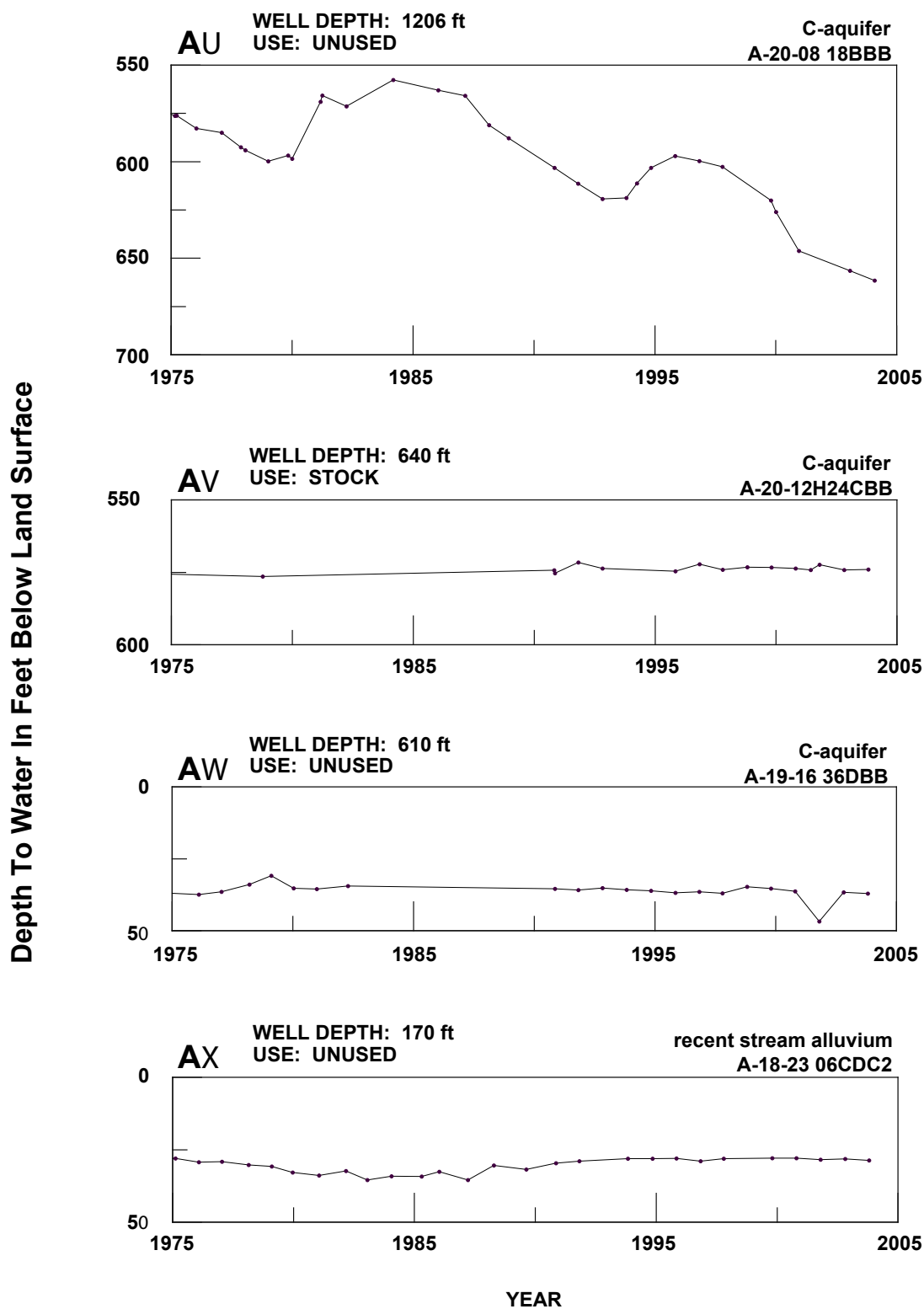


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

Depth To Water In Feet Below Land Surface

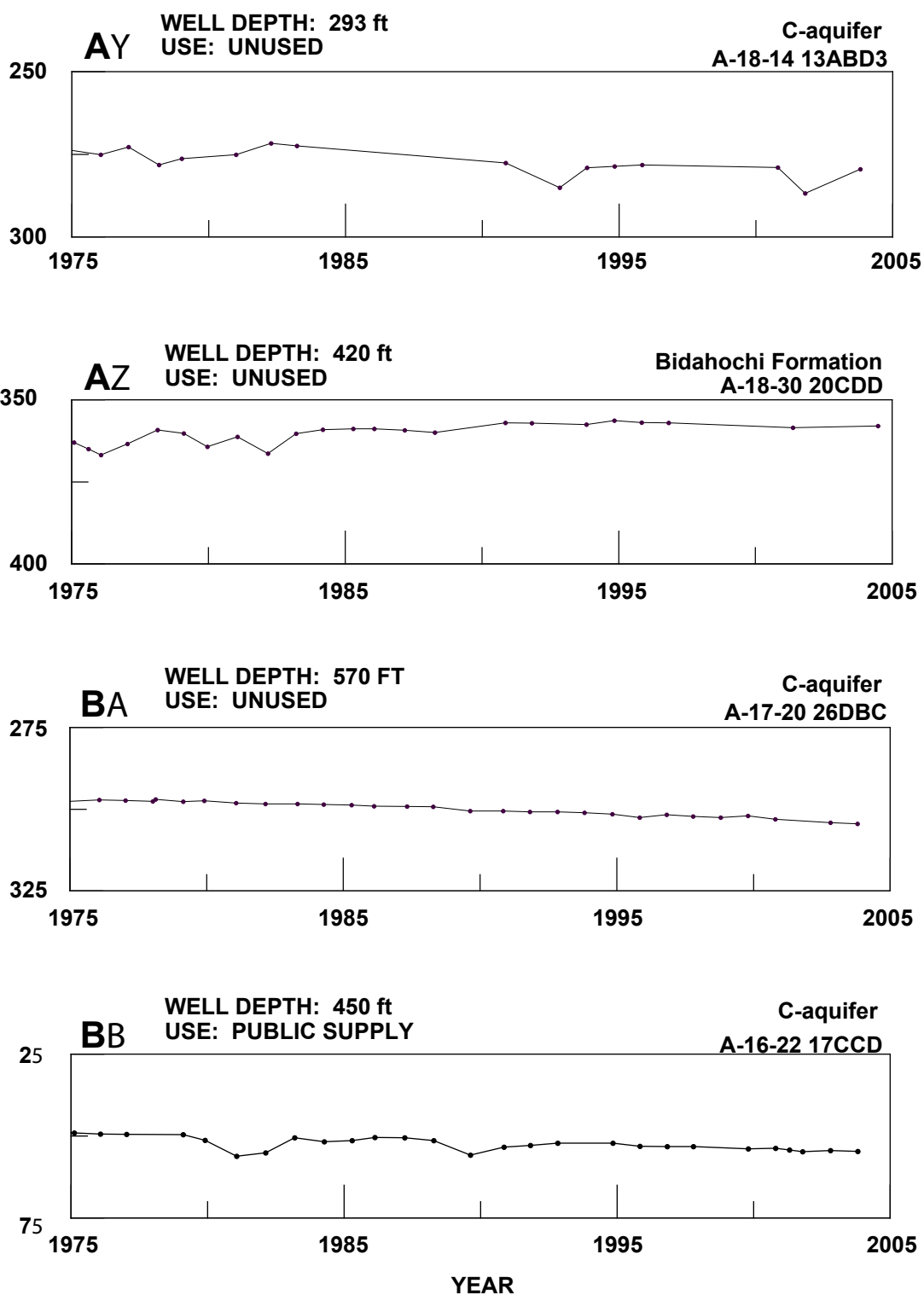


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

Depth To Water In Feet Below Land Surface

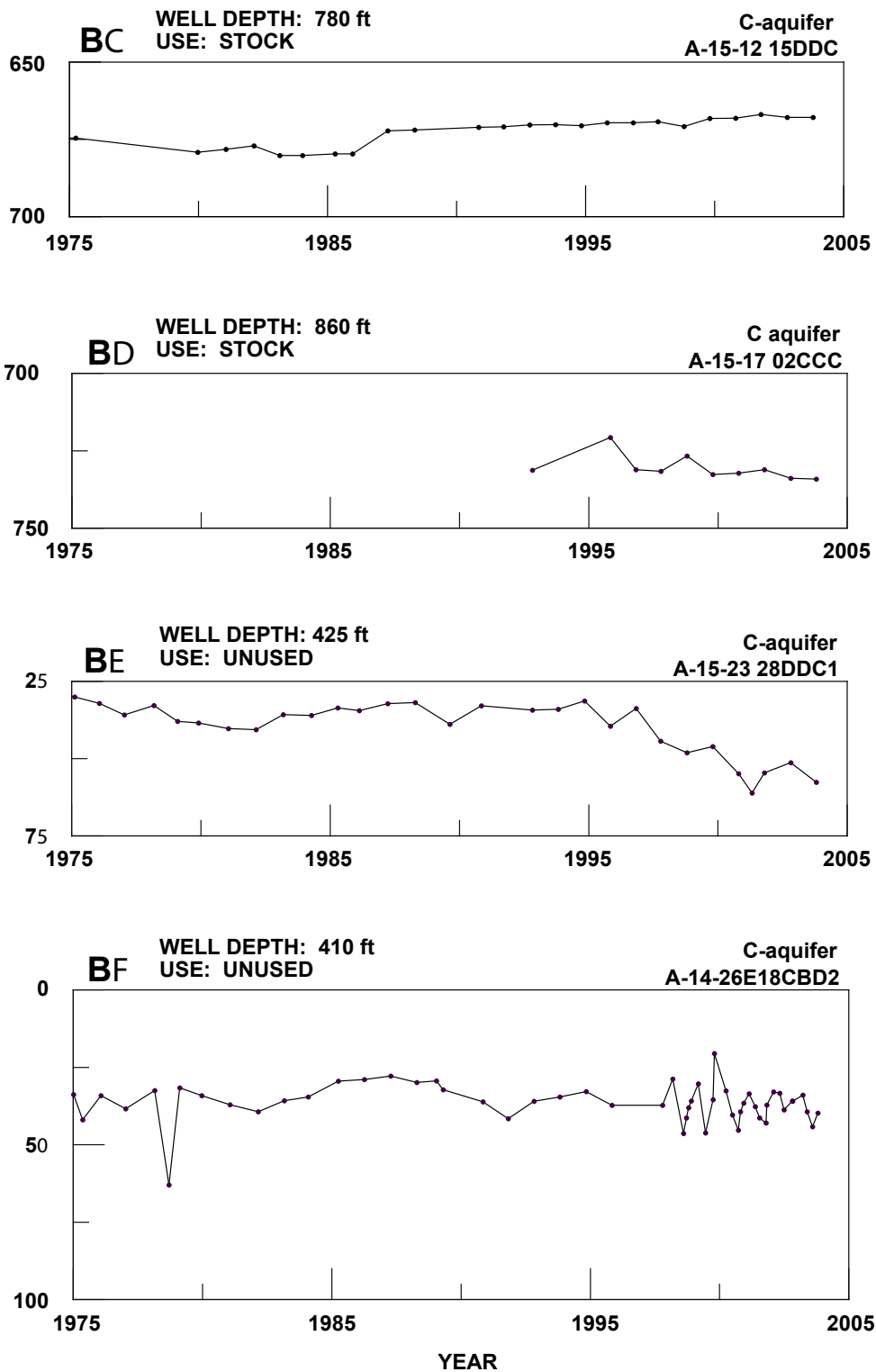


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

Depth To Water In Feet Below Land Surface

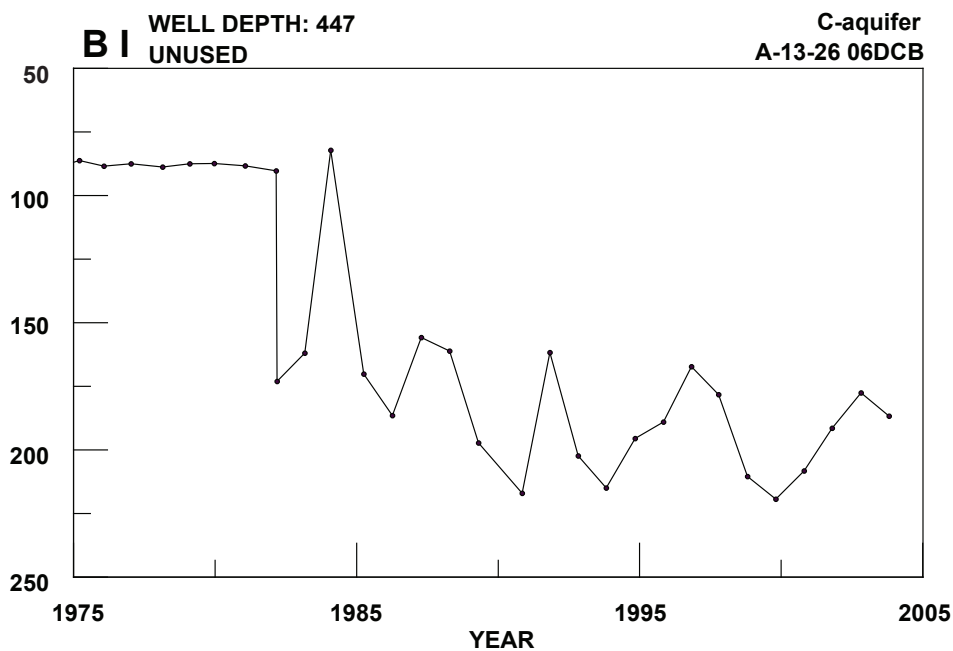
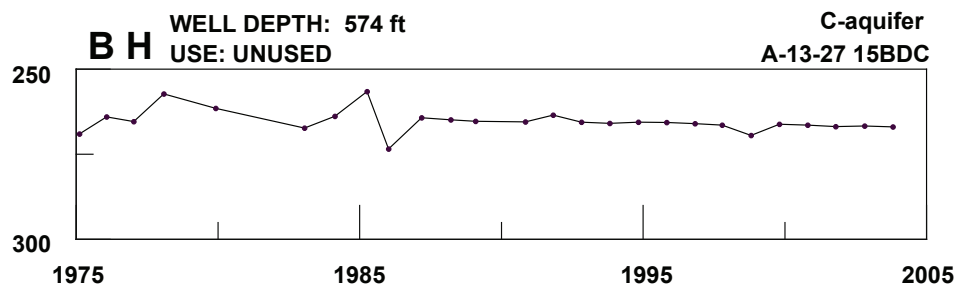
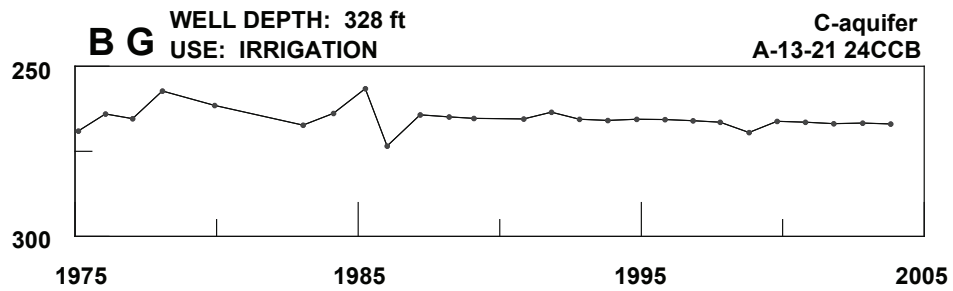


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

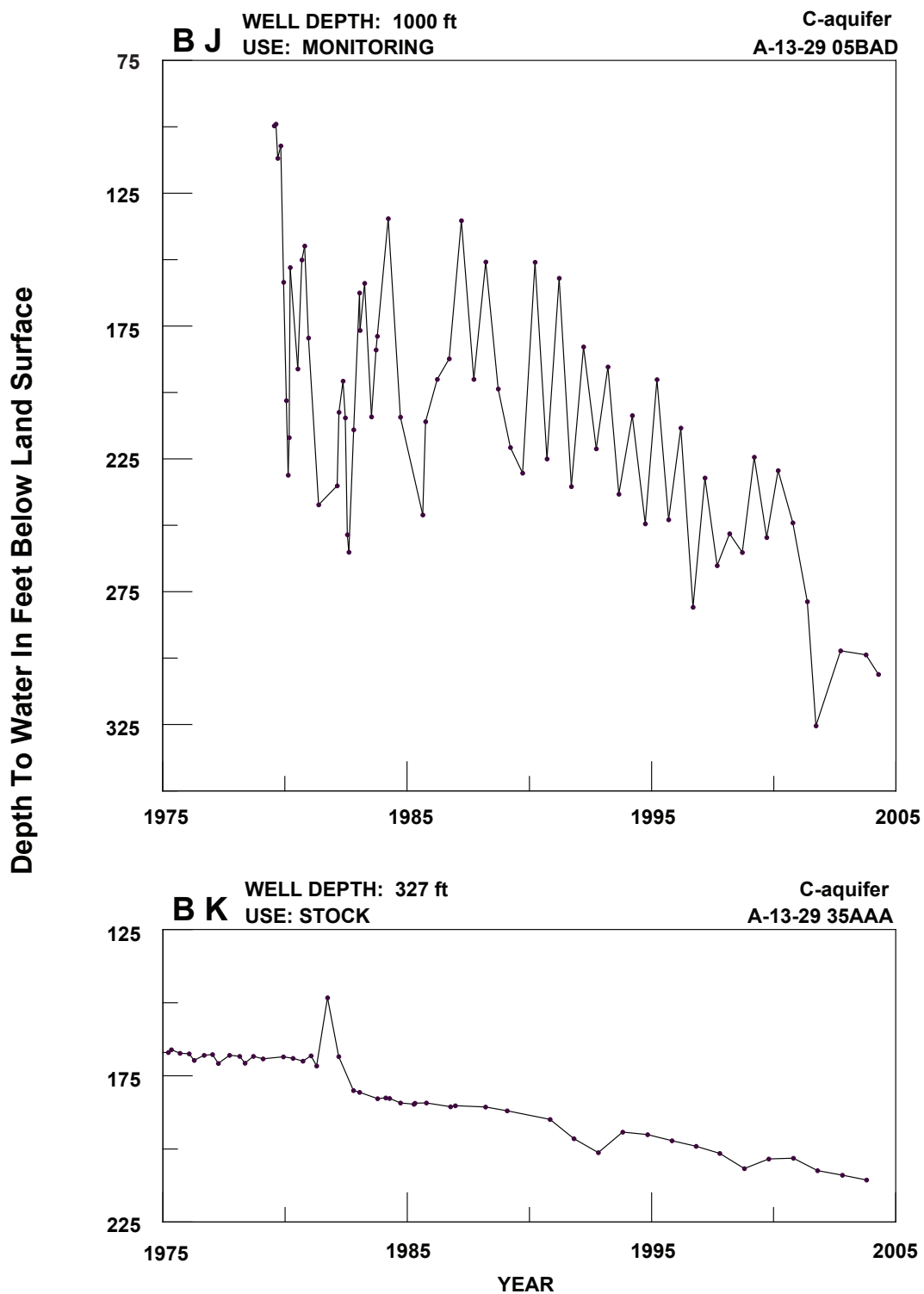


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued

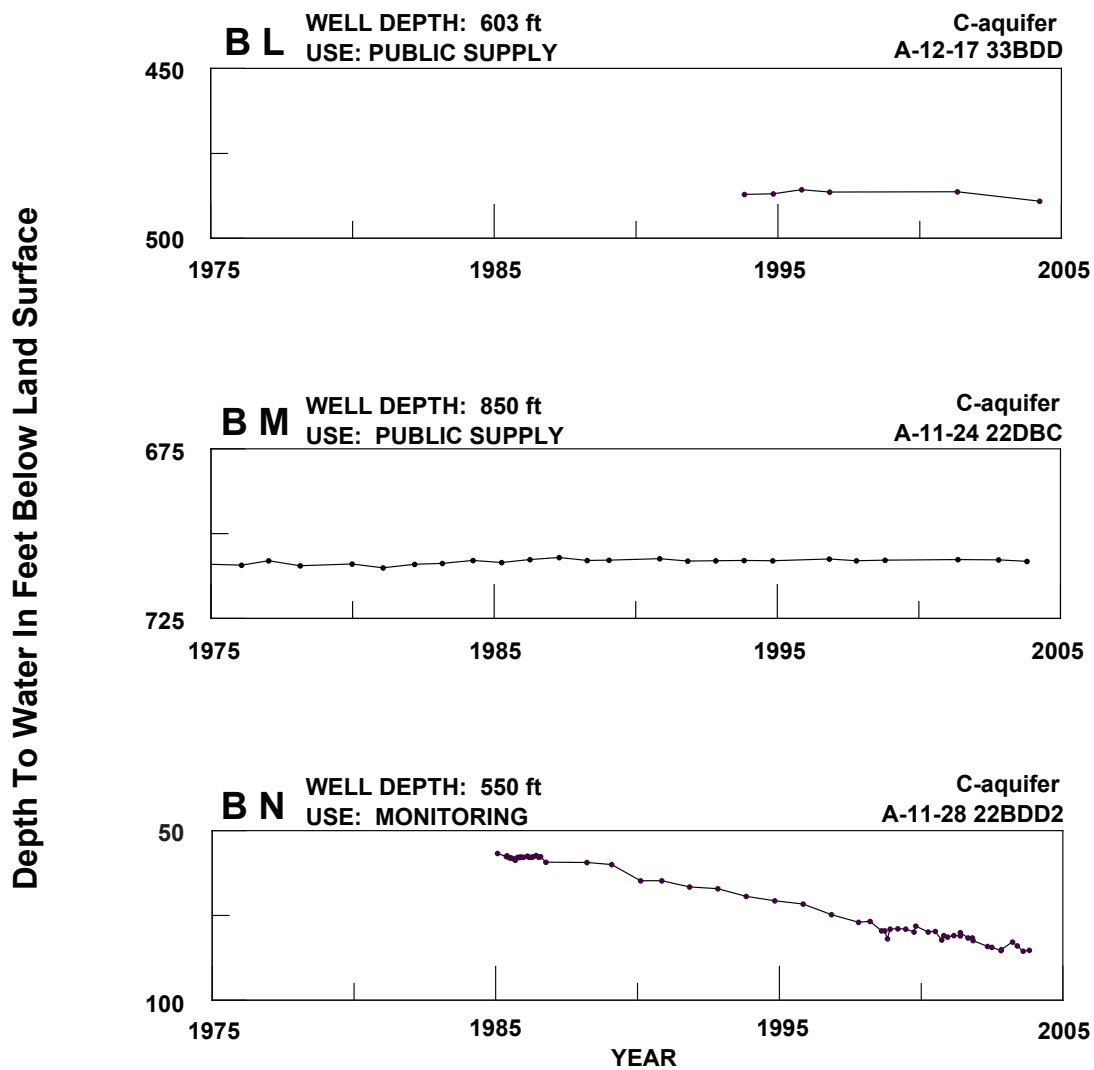
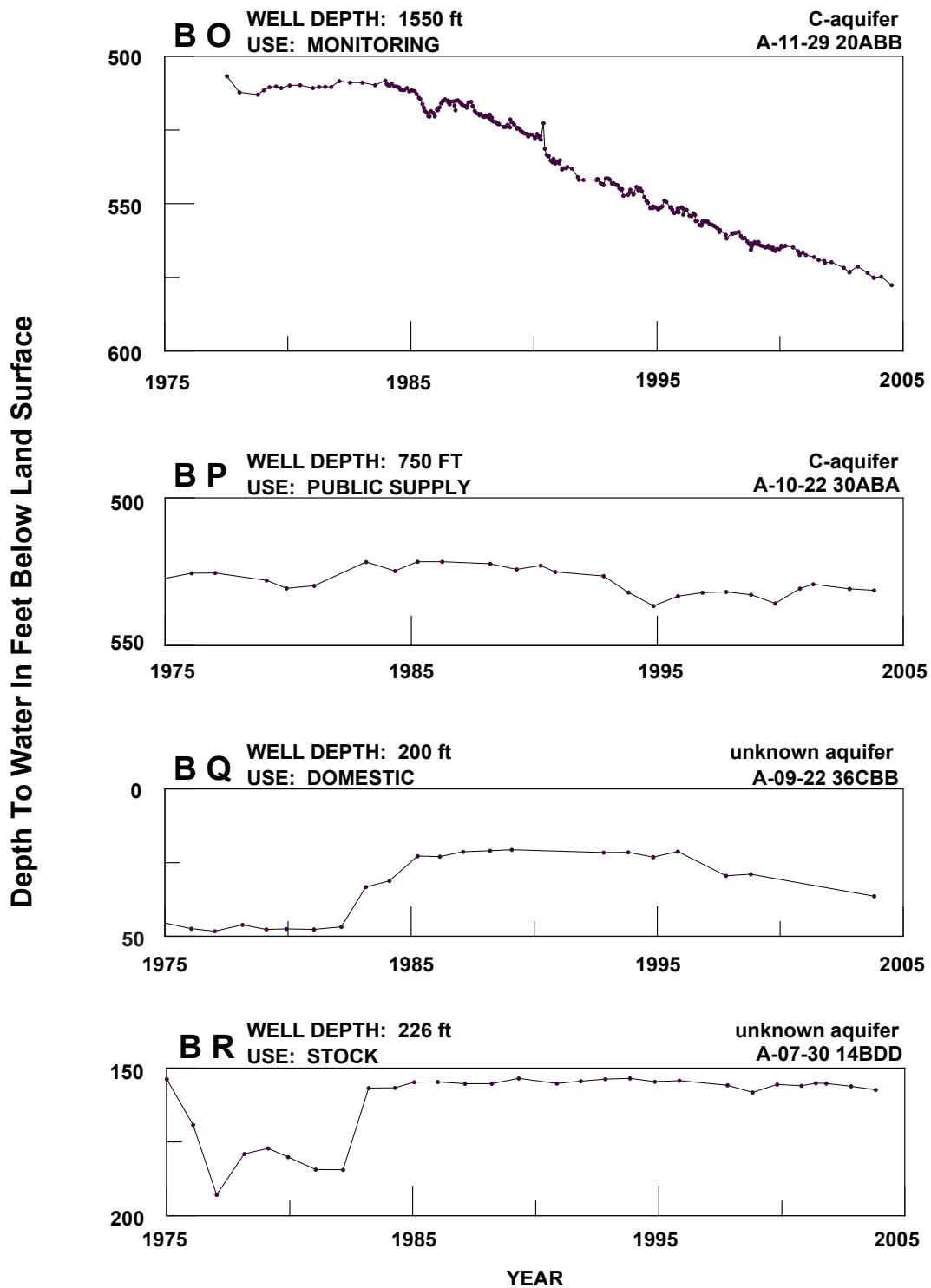
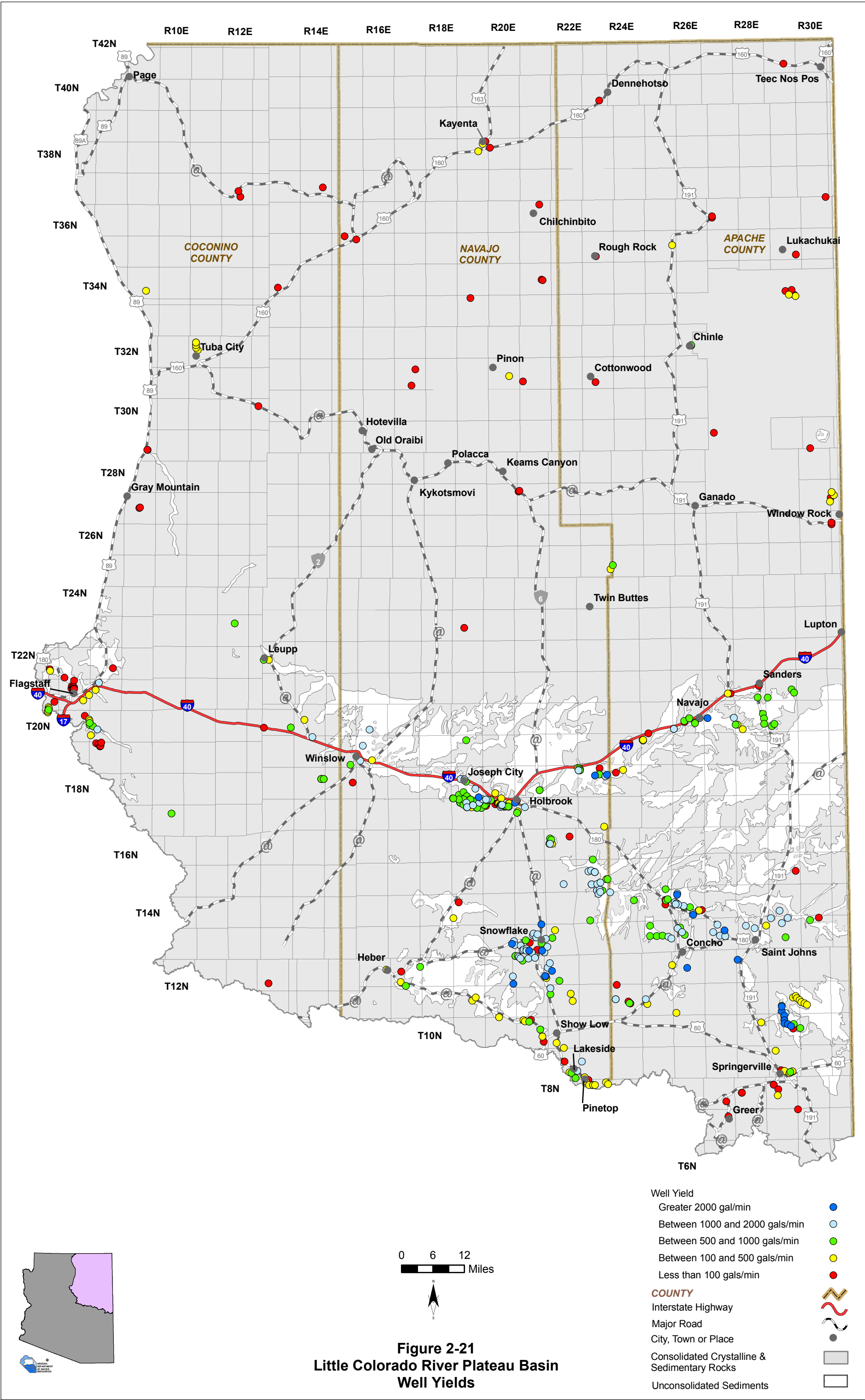


Figure 2-20. Little Colorado River Plateau
Hydrographs Showing Depth to Water in Selected Wells - continued





2.1.7 Water Quality of the Little Colorado River Plateau Basin

Drinking water standard exceedences in wells, springs and mine sites including location and parameter(s) exceeded are shown in Table 2-14A. Impaired lakes and streams with site type, name, length of impaired stream reach, area of impaired lake, designated use standard and parameter(s) exceeded is shown in Table 2-14B. Figure 2-22 shows the location of exceedences and impairment keyed to Table 2-14. A description of water quality data sources and methods is found in Volume 1, Section 1.3.18. Not all parameters were measured at all sites; selective sampling for particular constituents is common.

Wells, springs and mine sites

- Refer to Table 2-14A
- Drinking water standard exceedences in wells, springs and at mine sites have been reported at 237 sites in the basin.
- North of Highway 264, the parameters most frequently exceeded in the sites measured were thallium and radionuclides in both wells and springs
- Between Highway 264 and Interstate 40, the parameter most frequently exceeded in the sites measured was arsenic. There is a notable arsenic cluster in the vicinity of the Hopi communities of Polacca, Kykotsmovi and Keams Canyon.
- South of Interstate 40 the parameters most frequently exceeded in the sites measured were arsenic and cadmium.
- For the entire basin, the most frequently exceeded constituents measured, in order of greatest occurrence were arsenic, radionuclides, thallium, lead and TDS.

Lakes and streams

- Refer to Table 2-14B
- Water quality standards were exceeded in eight lakes, and at two reaches on Nutrioso Creek and at six reaches of the Little Colorado River
- The parameter most frequently exceeded in the lakes measured was mercury.
- Turbidity was the most frequently exceeded parameter in the Little Colorado River and Nutrioso Creek.

Table 2-14 Water Quality Exceedances in the Little Colorado River Plateau Basin

A. Wells, Springs and Mines

Map Key	Site Type	Site Location			Parameter(s) Exceeding Drinking Water Standard ²
		Township	Range	Section	
1	Well	41 North	30 East	34	TI
2	Well	41 North	29 East	14	TI
3	Spring	41 North	23 East	28	Pb
4	Well	41 North	19 East	21	As, Rad
5	Well	40 North	28 East	29	Rad
6	Well	40 North	28 East	18	Rad
7	Spring	40 North	28 East	13	Rad
8	Well	40 North	28 East	1	As
9	Well	40 North	27 East	26	As
10	Well	40 North	27 East	21	As
11	Well	40 North	27 East	14	Rad
12	Spring	39 North	39 East	31	Sb
13	Spring	39 North	39 East	31	TI
14	Spring	39 North	21 East	35	Rad, Se, TI
15	Spring	38 North	29 East	33	TI
16	Spring	38 North	28 East	2	Rad
17	Well	38 North	20 East	23	TI
18	Spring	38 North	7 East	28	Rad, TI
19	Well	37 North	31 East	19	Sb, TI
20	Well	37 North	29 East	27	Rad, TI
21	Well	37 North	29 East	26	Sb, Rad
22	Spring	37 North	29 East	2	TI
23	Spring	36 North	31 East	18	Rad
24	Spring	36 North	30 East	6	TI
25	Mine	36 North	29 East	33	Rad
26	Mine	36 North	29 East	21	As, Rad, Se, TI
27	Spring	36 North	29 East	18	TI
28	Mine	36 North	29 East	17	As, Rad, Se, TI
29	Spring	36 North	29 East	15	TI
30	Spring	36 North	29 East	14	Pb
31	Well	36 North	29 East	4	Rad, TI
32	Spring	36 North	28 East	1	TI
33	Spring	36 North	23 East	33	Rad, Se
34	Well	36 North	23 East	18	As, TI
35	Well	36 North	22 East	9	Pb
36	Mine	35 North	30 East	2	Rad
37	Well	35 North	23 East	27	As
38	Well	35 North	23 East	27	As
39	Well	35 North	23 East	27	As
40	Spring	35 North	23 East	18	Rad
41	Spring	35 North	23 East	8	Rad, TI
42	Spring	35 North	23 East	7	Rad, TI
43	Spring	35 North	22 East	17	TI
44	Well	34 North	23 East	20	TI
45	Well	34 North	22 East	8	TI
46	Well	34 North	21 East	23	As
47	Well	34 North	21 East	22	As, TI
48	Well	34 North	9 East	31	TI
49	Spring	33 North	24 East	7	Se
50	Well	33 North	23 East	32	TI
51	Spring	33 North	23 East	32	Rad
52	Spring	33 North	23 East	2	Rad
53	Well	33 North	11 East	27	Rad, TI
54	Spring	32 North	23 East	33	TI
55	Well	32 North	23 East	21	Rad
56	Well	32 North	20 East	6	TI
57	Well	32 North	12 East	21	As, Pb, Rad
58	Spring	32 North	12 East	14	TI

Table 2-14 Water Quality Exceedances in the Little Colorado River Plateau Basin

A. Wells, Springs and Mines cont'd.

Map Key	Site Type	Site Location			Parameter(s) Exceeding Drinking Water Standard ²
		Township	Range	Section	
59	Spring	32 North	11 East	33	TI
60	Well	32 North	11 East	29	TI
61	Spring	32 North	9 East	2	As, TI
62	Spring	31 North	24 East	5	TI
63	Well	31 North	23 East	21	Rad
64	Spring	30 North	19 East	25	Pb
65	Spring	30 North	10 East	16	Rad
66	Well	29 North	21 East	5	As, TDS
67	Well	29 North	19 East	33	FI
68	Spring	29 North	18 East	26	Se
69	Spring	29 North	15 East	12	NO3
70	Well	29 North	12 East	7	TI
71	Well	29 North	9 East	33	TDS
72	Mine	29 North	9 East	25	As, Ba, Pb, Rad
73	Well	29 North	9 East	22	TDS
74	Well	29 North	9 East	15	NO3
75	Mine	29 North	9 East	11	As, Ba, Be, Cd, Pb, Rad
76	Well	28 North	19 East	21	As
77	Well	28 North	19 East	21	As
78	Well	28 North	19 East	9	As
79	Well	28 North	19 East	9	As
80	Well	28 North	18 East	22	As, Pb
81	Well	28 North	18 East	14	As
82	Well	28 North	18 East	14	As
83	Well	28 North	17 East	28	As
84	Well	28 North	17 East	27	As
85	Well	28 North	17 East	27	As
86	Well	28 North	17 East	26	As
87	Well	28 North	17 East	26	As
88	Well	28 North	17 East	26	As
89	Well	28 North	17 East	9	As
90	Well	28 North	17 East	9	As
91	Well	28 North	10 East	5	Pb
92	Well	27 North	15 East	16	NO3
93	Spring	27 North	12 East	27	As, Rad
94	Spring	27 North	11 East	26	As, Rad, TI
95	Well	27 North	11 East	19	As, Rad
96	Well	27 North	10 East	6	Pb
97	Well	27 North	9 East	11	TDS
98	Well	26 North	23 East	35	As, Rad
99	Well	26 North	22 East	35	As
100	Spring	26 North	22 East	31	As
101	Spring	26 North	17 East	7	TDS
102	Spring	26 North	11 East	14	As, Rad, TI
103	Well	26 North	10 East	16	TDS
104	Well	26 North	10 East	9	TDS
105	Spring	26 North	10 East	2	TI
106	Well	25 North	23 East	19	As, Rad
107	Well	25 North	22 East	35	As
108	Well	25 North	22 East	35	Ba
109	Well	25 North	22 East	17	TI
110	Spring	25 North	22 East	6	As TI
111	Well	25 North	21 East	22	Ba, TI
112	Well	25 North	20 East	34	As
113	Well	25 North	20 East	22	As
114	Well	25 North	10 East	30	Pb
115	Well	24 North	24 East	24	As
116	Spring	24 North	23 East	1	As, Rad, Se, TI

Table 2-14 Water Quality Exceedances in the Little Colorado River Plateau Basin

A. Wells, Springs and Mines cont'd.

Map Key	Site Type	Site Location			Parameter(s) Exceeding Drinking Water Standard ²
		Township	Range	Section	
117	Well	24 North	18 East	11	Ba
118	Spring	23 North	23 East	4	As, Rad
119	Spring	23 North	22 East	8	As
120	Well	23 North	21 East	14	Ba
121	Well	23 North	19 East	21	Ba
122	Spring	23 North	17 East	24	As
123	Well	22 North	31 East	9	Rad
124	Well	22 North	31 East	8	Rad
125	Well	22 North	31 East	8	Cd
126	Well	22 North	31 East	8	Pb
127	Well	22 North	31 East	8	As
128	Well	22 North	31 East	8	Cd
129	Well	22 North	31 East	8	Pb
130	Well	22 North	31 East	8	Cd
131	Well	22 North	31 East	5	Rad
132	Well	22 North	30 East	27	Cd
133	Well	22 North	30 East	22	Cd, Rad
134	Spring	22 North	21 East	4	TI
135	Spring	22 North	19 East	9	As
136	Spring	22 North	18 East	10	As
137	Well	22 North	8 East	27	Ba
138	Well	22 North	6 East	26	NO3
139	Well	22 North	6 East	26	NO3
140	Well	21 North	28 East	30	Rad
141	Well	21 North	28 East	30	Rad
142	Well	21 North	28 East	28	Cd
143	Well	21 North	28 East	24	Cd
144	Well	21 North	28 East	24	As
145	Well	21 North	28 East	23	Rad
146	Well	21 North	28 East	20	As
147	Well	21 North	28 East	13	Cd
148	Well	21 North	28 East	10	As, Cd, Rad
149	Well	21 North	27 East	35	Be
150	Well	21 North	27 East	25	Be
151	Well	21 North	27 East	25	F
152	Well	21 North	27 East	25	As, Cd
153	Well	21 North	7 East	25	Pb, NO3
154	Well	21 North	7 East	20	As
155	Well	21 North	7 East	20	TDS
156	Well	21 North	7 East	19	As
157	Well	21 North	7 East	9	As
158	Well	21 North	6 East	25	As, Sb
159	Well	21 North	6 East	23	As
160	Well	20 North	29 East	20	As
161	Spring	20 North	28 East	32	As
162	Spring	20 North	27 East	28	As
163	Spring	20 North	27 East	26	Rad
164	Well	20 North	27 East	4	As
165	Well	20 North	25 East	28	F
166	Well	20 North	25 East	15	F
167	Well	20 North	19 East	15	TDS
168	Well	19 North	28 East	4	As
169	Well	19 North	26 East	32	As
170	Well	19 North	25 East	11	Cd, Rad
171	Well	19 North	23 East	19	TDS
172	Well	19 North	23 East	3	Rad
173	Well	19 North	16 East	28	TDS
174	Well	19 North	16 East	20	TDS

Table 2-14 Water Quality Exceedances in the Little Colorado River Plateau Basin

A. Wells, Springs and Mines cont'd.

Map Key	Site Type	Site Location			Parameter(s) Exceeding Drinking Water Standard ²
		Township	Range	Section	
175	Well	19 North	9 East	17	Ba
176	Well	18 North	24 East	16	As, Rad
177	Well	18 North	24 East	16	As, Rad
178	Well	18 North	24 East	8	Be, F, TDS
179	Well	17 North	26 East	13	F
180	Well	17 North	22 East	17	TDS
181	Well	17 North	19 East	28	Cd, Pb
182	Well	16 North	30 East	14	TDS
183	Well	16 North	28 East	35	TDS
184	Well	16 North	28 East	18	NO3
185	Well	16 North	25 East	6	F
186	Well	16 North	22 East	14	F
187	Well	16 North	18 East	9	TDS
188	Well	14 North	30 East	21	F
189	Well	14 North	30 East	7	F
190	Well	14 North	27 East	15	TDS
191	Well	14 North	27 East	1	TDS
192	Well	14 North	25 East	4	As
193	Well	14 North	16 East	9	As
194	Well	13 North	28 East	29	F
195	Well	13 North	28 East	28	TDS
196	Well	13 North	28 East	20	F
197	Well	13 North	27 East	31	NO3
198	Well	13 North	21 East	26	NO3
199	Well	13 North	21 East	26	NO3
200	Well	12 North	28 East	18	F
201	Spring	12 North	28 East	17	As
202	Well	12 North	28 East	17	F
203	Well	12 North	26 East	13	Be
204	Well	12 North	18 East	28	As
205	Well	12 North	17 East	33	Cd, Se
206	Well	12 North	17 East	32	As, Cd, Se
207	Well	12 North	17 East	30	Cd, Se
208	Well	12 North	17 East	21	Cd, Se
209	Well	12 North	16 East	15	Pb
210	Well	11 North	29 East	28	As
211	Well	11 North	29 East	7	As
212	Well	11 North	28 East	9	As
213	Well	11 North	22 East	23	As
214	Well	11 North	21 East	34	As, Cd
215	Well	11 North	20 East	29	As, Cd
216	Well	11 North	19 East	18	Cd
217	Well	11 North	14 East	11	As
218	Well	10 North	25 East	22	Cd
219	Well	10 North	25 East	22	Cd
220	Well ³	10 North	23 East	22	Cd
221	Well	10 North	22 East	32	Cd
222	Well	10 North	22 East	14	As
223	Well	10 North	21 East	13	Pb
224	Well	10 North	21 East	3	As
225	Well	10 North	21 East	3	As, Cd
226	Well	10 North	20 East	20	Cd, Pb, Se
227	Well	10 North	20 East	13	Be, Cd
228	Well	9 North	23 East	22	Cd
229	Well	9 North	22 East	26	Pb, Cd
230	Well	9 North	22 East	25	Cd
231	Well	8 North	29 East	9	Pb
232	Well	8 North	23 East	10	Cu, Pb

Table 2-14 Water Quality Exceedances in the Little Colorado River Plateau Basin

A. Wells, Springs and Mines cont'd.

Map Key	Site Type	Site Location			Parameter(s) Exceeding Drinking Water Standard ²
		Township	Range	Section	
233	Well	7 North	26 East	14	NO3
234	Well	NA	NA	NA	Pb, TI
235	Spring	NA	NA	NA	As, Pb, Rad
236	Spring	NA	NA	NA	TI
237	Well	NA	NA	NA	TI

B. Lakes and Streams

Map Key	Site Type	Site Name	Length of Impaired Stream Reach (in miles)	Area of Impaired Lake (in acres)	Designated Use Standard ⁴	Parameter(s) Exceeding Use Standard ²
a	Lake	Bear Canyon	NA	55	A&W, AgI, AgL, FBC	DO, Se
b	River	Little Colorado River (Nutrioso Creek to Carnero Wash)	12	NA	A&W	Turbidity
c	River	Little Colorado River (Porter Tank to McDonalds Wash)	17	NA	A&W	Cu, Ag
d	River	Little Colorado River (Silver Creek to Carr Wash)	6	NA	A&W	Pb
e	River	Little Colorado River (unnamed tributary to Lyman Lake)	3	NA	A&W	Turbidity
f	River	Little Colorado River (Water Canyon Creek to Nutrioso Creek)	4	NA	A&W	Turbidity
g	River	Little Colorado River (West Fork to Water Canyon Creek)	20	NA	A&W	Turbidity
h	Lake	Long Lake (lower)	NA	323	FC	Hg

Table 2-14 Water Quality Exceedances in the Little Colorado River Plateau Basin

B. Lakes and Streams cont'd.

Map Key	Site Type	Site Name	Length of Impaired Stream Reach (in miles)	Area of Impaired Lake (in acres)	Designated Use Standard ⁴	Parameter(s) Exceeding Use Standard ²
i	Lake	Lower Lake Mary	NA	764	FC	Hg
j	Lake	Lyman	NA	1,308	FC	Hg
k	Stream	Nutrios Creek (headwaters to Picnic Creek)	27	NA	A&W	Turbidity
l	Stream	Nutrios Creek (Picnic Creek to Little Colorado River)	4	NA	A&W	Turbidity
m	Lake	Rainbow	NA	111	A&W, AgI, AgL, FBC	DO, NO3, P, pH
n	Lake	Soldiers	NA	28	FC	Hg
o	Lake	Soldiers Annex	NA	122	FC	Hg
p	Lake	Upper Lake Mary	NA	760	FC	Hg

Notes:

NA = Not applicable

¹Most water quality samples collected between 1975 and 2003. One sample was collected in 1951.

² Sb = Antimony

As = Arsenic

Ba = Barium

Be = Beryllium

Cd = Cadmium

Cu = Copper

DO = Dissolved oxygen

F= Fluoride

Pb = Lead

Hg = Mercury

NO3 = Nitrate/Nitrite

P = Phosphorous

Se = Selenium

Ag = Silver

TDS = Total Dissolved Solids

Tl = Thallium

Rad = One or more of the following radionuclides - Gross Alpha, Gross Beta, Radium, and Uranium

³ Conflicting locational information

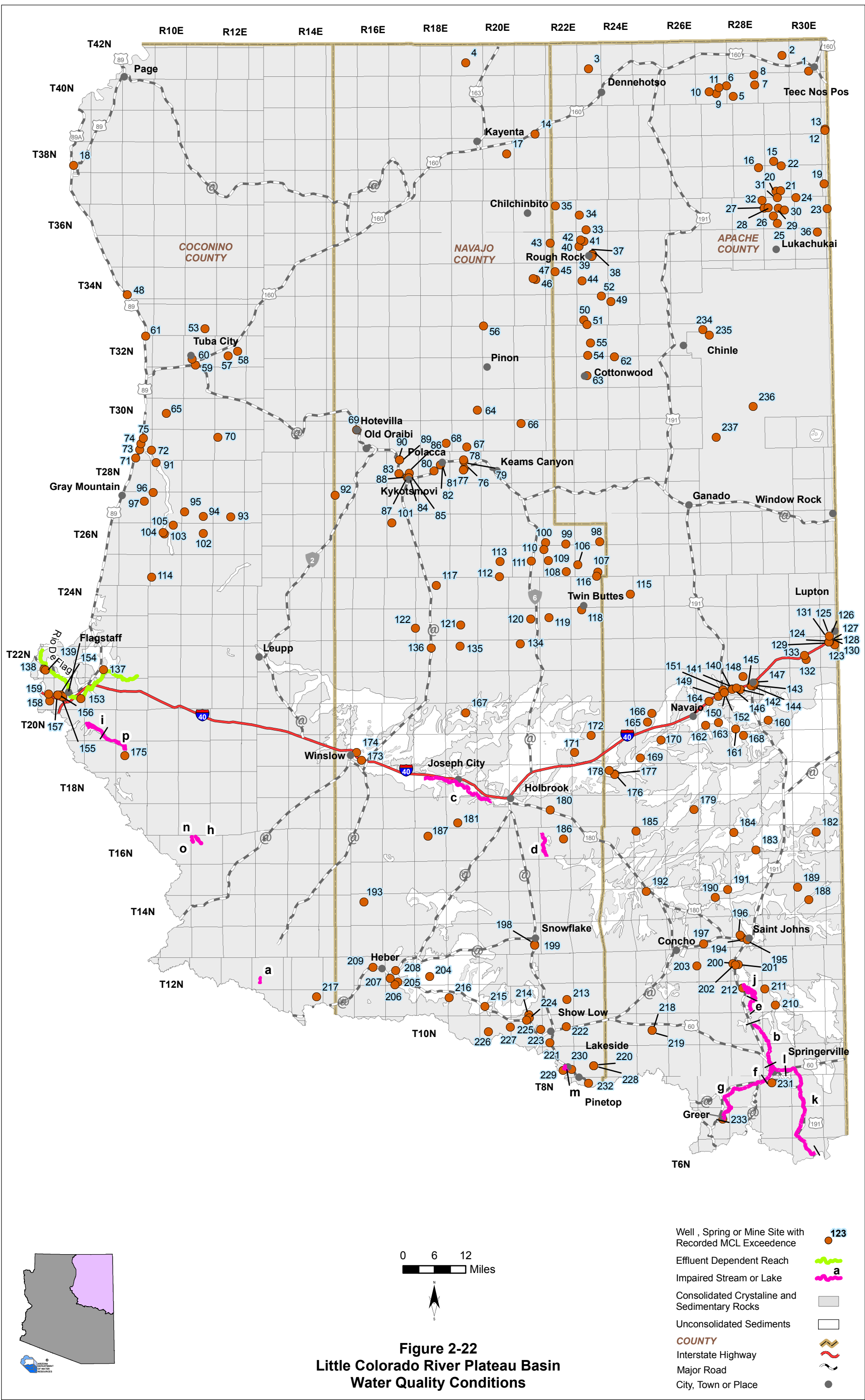
⁴ A&W = Aquatic and Wildlife

AgI = Agricultural Irrigation

AgL = Agricultural Livestock Watering

FBC = Full Body Contact

FC = Fish Consumption



2.1.8 Cultural Water Demands in the Little Colorado River Plateau Basin

Cultural water demand data including population, number of wells, and the average well pumpage and surface water diversions by the municipal, industrial and agricultural sectors are shown in Table 2-15. Effluent generation including facility ownership, location, population served and not served, volume treated, disposal method and treatment level is shown in Table 2-16. Figure 2-23 shows the location of demand centers. A description of cultural water demand data sources and methods is found in Volume 1, Section 1.3.5. More detailed information on cultural water demands is found in Section 2.0.7.

Cultural Water Demands

- Refer to Table 2-15 and Figure 2-23.
- Population increased by an average of 3,700 people per year between 1980 and 2000. Projections suggest a more rapid rate of growth through 2050.
- Total groundwater pumping is increasing with an average of 122,000 acre-feet pumped per year in the period from 2001-2003.
- Total surface water diversions are estimated to be comparable to historic diversion volumes with 82,500 acre-feet diverted per year in the period from 2001-2003. Municipal surface water diversions, however appear to be declining.
- Approximately 4,000 acre-feet of surface water is diverted per year for municipal use
- Most high intensity municipal and industrial (M&I) use is found in the population centers of Flagstaff, Page, Show Low/Pinetop-Lakeside, Taylor/Snowflake and Winslow/Holbrook.
- Industrial use has remained relatively constant with an average of 86,500 acre-feet of surface water and groundwater used per year during the 2001-2003 period.
- Approximately two-thirds of the industrial water supply is groundwater.
- Location of power plants and mines are shown on Figure 2-23 including the extent of the large Black Mesa and Kayenta coal mines south of Kayenta. Power plants/electrical generating stations are Cholla, near Joseph City, Coronado near St. Johns, Navajo at Page and the Springerville power plant located northeast of Springerville.
- Agricultural use is estimated to have declined slightly since 1991
- Surface water is the primary agricultural water supply, comprising about 60% of the total supply.
- Large tracts of agricultural lands are found along Highway 191 on the Navajo Reservation and in the vicinity of Snowflake, Springerville, Saint Johns and Holbrook. The large agricultural area northeast of Heber is pasture irrigated with wastewater from the Abitibi paper mill, an industrial user.

Effluent Generation

- Refer to Table 2-16.
- There are 61 wastewater treatment facilities in the basin.
- The population served appears to be overestimated for the basin as a whole. Multiple databases were used to compile the effluent generation information and may contain flawed population estimates.
- More than 36,000 acre-feet of effluent per year are generated in the basin. Almost a third of this volume is generated by a single facility, the Abitibi paper mill.
- Nine facilities discharge waste water for irrigation.

- Effluent is used to irrigate seven golf courses.
- Discharge from 14 facilities recharges the aquifer through an unlined impoundment. There are no facilities permitted by the Department as Underground Storage Facilities.

Table 2-15 Cultural Demands in the Little Colorado River Plateau Basin¹

Year	Recent (Census) and Projected (DES) Population	Number of Registered Water Supply Wells Drilled		Average Annual Demand (in acre-feet)						Data Source
				Well Pumpage			Surface-Water Diversions			
		Q < 35 gpm	Q ≥ 35 gpm	Municipal	Industrial	Irrigation	Municipal	Industrial	Irrigation	
1971		2,865 ²	745 ²	60,000			85,000			ADWR (1994)
1972										
1973										
1974				77,000			85,000			
1975										
1976										
1977										
1978										
1979										
1980	175,451	892	88	90,000			85,000			
1981	178,851									
1982	182,252									
1983	185,652									
1984	189,052									
1985	192,452									
1986	195,853	691	36	93,000			85,000			
1987	199,253									
1988	202,653									
1989	206,053									
1990 ³	209,454									
1991	213,493	768	31	21,000	53,000	35,500	7,100	30,500	50,000	ADWR (2003, 2004a,b & 2005), Truini (2005), USGS (2005), WIFA (2005)
1992	217,532									
1993	221,571									
1994	225,610									
1995	229,649									
1996	233,688	1,181	39	24,500	54,000	34,500	5,500	32,000	48,500	
1997	237,727									
1998	241,766									
1999	245,805									
2000	249,844									
2001	255,141	467	15	29,000	56,500	34,500	4,000	30,000	48,500	
2002	260,437									
2003	265,734									
2010	302,811									
2020	342,207									
2030	381,697									
2040	423,531									
2050	473,296									

ADDITIONAL WELLS:⁴ 553 4
WELL TOTALS: 7,417 958

¹ Does not include evaporation losses from stockponds and reservoirs.

² Includes all wells through 1980.

³ In 1990, 113,000 acre-feet were used for municipal and industrial demands and 89,000 acre-feet were used for irrigation.

⁴ Other water-supply wells are listed in the ADWR Well Registry for this basin, but they do not have completion dates. These wells are summed here.

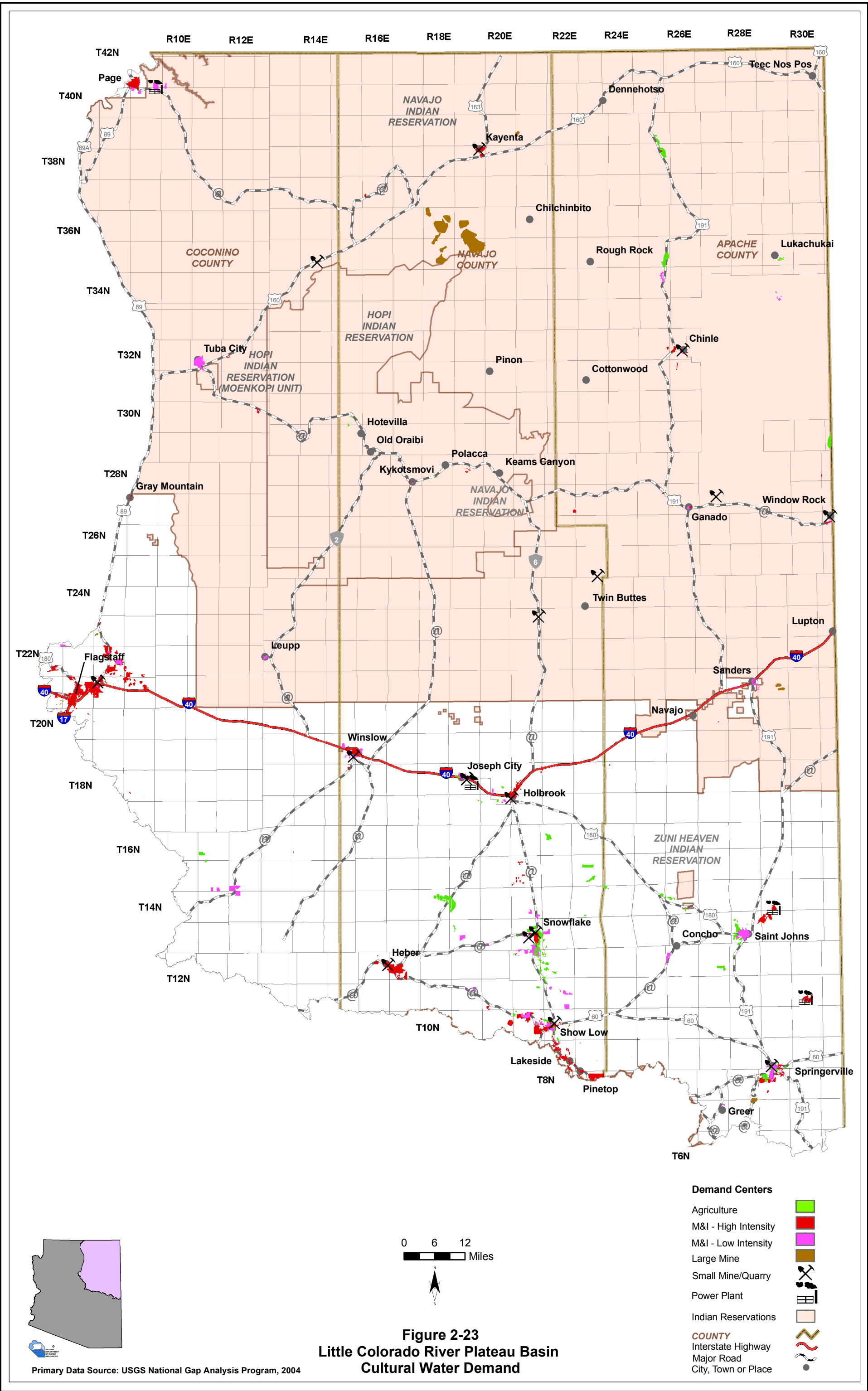


Table 2-16 Effluent Generation in the Little Colorado River Plateau Basin

Facility Name	Ownership	City/Location Served	Population Served	Volume Treated/Generated (acre-feet/year)	Disposal Method							Current Treatment Level	Population Not Served	Year of Record
					Water-course	Evaporation Pond	Irrigation	Wildlife Area	Golf Course/Turf Irrigation	Discharge to Another Facility	Groundwater Recharge			
Abitibi	Private	Industrial	NA	11,862			X					Primary	NA	2005
Bacobi WWTP	Hopi Tribe	Bacobi	550	62							X	NA	70	2000
Bison Ranch WWTP	Private	Overgaard	NA											
Black Mesa Ranger District	Apache Sitgreaves National Forest	Forest Service Facilities	NA											
Black Mesa Sewer System	Navajo Nation	Black Mesa	305	34							X	Secondary	100	2000
Cameron WWTF	Navajo Nation	Cameron	190	11							X	NA	380	2000
Chilchinbito Sewer System	Navajo Nation	Chilchinbeto	150	17		X						Secondary	600	1999
Chinle WWTP	Navajo Nation	Chinle	7,775	493		X						Secondary	750	1998
Cottonwood Sewer System	Navajo Nation	Cottonwood	1,000	112		X						Secondary	645	2000
Dennehotso	Navajo Nation	Dennehotso	1,000	112	X							Secondary	1,115	2000
Dilkon WWTF	Navajo Nation	Dilkon	1,408	134	X							Secondary	850	2000
Eager WWTP	Town of Eagar	Eagar	4,500	269	NA							Adv. Trt.II	1,400	2001
Flagstaff Ranch Development WWTP	Private	Flagstaff	NA						Flagstaff Ranch			NA		
Fort Valley Meadow Subdivision	Private	Flagstaff	NA											
Ganado Burnwater Phase IX	Navajo Nation	Ganado	3,000	336							X	Secondary	500	1998
Ganado WWTP	Navajo Nation	Ganado	851	157							X	Secondary	51	1996
Ganado Wood Springs II	Navajo Nation	Ganado	NA	45							X	NA		2000
Glen Canyon NRA WWTF	National Park Service	Recreation Area	NA											
Greenhaven WWTP	Private	Page	26	13		X						NA		2003
Greer WWTP	Little Colorado SD	Greer	600	56							X	Secondary	300	2000
Houck Burnwater Phase I	Navajo Nation	Houck	300	34							X	Secondary	300	2001
Inscription House Septics	Navajo Nation	Inscription House	1,000	112		X						Secondary	250	2000
Joseph City WWTF	Town of Joseph City	Joseph City	1,300	314		X						Secondary	60	2000
Kachina Village WWTP	Kachina Village ID	Kachina Village	5,000	426			X					Secondary	NA	2001
Kayenta WWTP	Navajo Nation	Kayenta	3,270	627	Laguana & Chinle Washes							Secondary	750	2000
Le Chee Sewer System	Navajo Nation	Le Chee	150	17		X						Secondary	165	2000
Leupp WWTF	Navajo Nation	Leupp	400	45		X						Secondary	NA	1999
Linden Trails WWTP	NA	Show Low	NA											
Livco Sewer Co.	Private	Concho	NA	3		X						NA		2003
Lukachukai	Navajo Nation	Lukachukai	200	22		X						Secondary	1,540	2000
Many Farms	Navajo Nation	Many Farms	685	34	X							Secondary	620	2000
Moenkopi WWTF	Hopi Tribe	Moenkopi	1,385	NA		X						NA		
Navajo Govt. Complex	Navajo County	Holbrook	700	45		X						Secondary	NA	2004

Table 2-16 Effluent Generation in the Little Colorado River Plateau Basin

Facility Name	Ownership	City/Location Served	Population Served	Volume Treated/Generated (acre-feet/year)	Disposal Method							Current Treatment Level	Population Not Served	Year of Record
					Water-course	Evaporation Pond	Irrigation	Wildlife Area	Golf Course/Turf Irrigation	Discharge to Another Facility	Groundwater Recharge			
Nazali WWTF	Navajo Nation	Ganado	1,493	157		X						Secondary	NA	2000
Oraibi	Hopi Tribe	Oraibi	500	56		X						Secondary	NA	2000
Page WWTF	City of Page	Page	7,500	1,120					Lake Powell	X		Adv. Trt. I	NA	2000
Painted Mesa WWTF	City of Holbrook	Holbrook	6,000	728		X	X		Hidden Cove			Adv. Trt.I	NA	2004
Pinetop Lakeside WWTF	Pinetop-Lakeside SD	Pinetop-Lakeside	20,000	1,792							X	Adv. Trt. II	2,200	2004
Pinon WWTP	Navajo Nation	Pinon	2,050	213	NA							Secondary	700	2000
Rio De Flag WWTP ¹	City of Flagstaff	Flagstaff	20,000	2,722	Rio De Flag		X	X	X			Adv. Trt. II	NA	2004
Rough Rock WWTF	Navajo Nation	Rough Rock	839	11	NA							Secondary	635	2000
Sanders Unifed School District	NA	Sanders	NA											
Show Low WWTF	City of Show Low	Show Low	8,800	896	X	X						Secondary	1,500	2004
Shungopavi WWTF	Hopi Tribe	Shungopavi	400	45		X						Secondary	NA	2000
Sipaulovi WWTF	Hopi Tribe	Sipaulovi	500	56		X						Secondary	200	2000
Snowflake WWTF	Town of Snowflake	Snowflake	3,600	282			X					Adv.Trt.I	600	2000
Springerville WWTF	Town of Springerville	Springerville	1,400	224	NA							Secondary	NA	2000
St. Johns WWTP	Town of St. John's	St.Johns	3,340	446			X					Secondary	159	2000
St. Micheals WWTF	Hopi Tribe	St.Micheals	500	50		X						Secondary	450	1999
Sweetwater Sewer System	Navajo Nation	Sweetwater	200	22							X	Secondary	200	2001
Taylor WWTF	Town of Taylor	Taylor	2,400	202		X						Secondary	1,200	2004
Tec Nos Pos WWTF	Navajo Nation	Tec Nos Pos	400	22							X	Secondary	1,399	2000
Tolani-Red Lake Sewer System	Navajo Nation	Tolani-Red Lake	100	11							X	Secondary	100	2000
Tsaile WWTF	Navajo Nation	Tsaile	4,861	448							X	Secondary	500	2000
Tuba City WWTF	Navajo Nation	Tuba City	12,443	448			X					Secondary	350	2000
Waweep WWTF	National Park Service	Park	NA											
Wide Ruins Sewer System	Navajo Nation	Wide Ruin	245	11							X	Secondary	245	1999
Wildcat WWTP	City of Flagstaff	Flagstaff	60,988	8,177	Rio De Flag		X		X			Adv. Trt II	NA	2004
Window Rock WWTP	Navajo Nation	Window Rock	10,650	986	Black Creek							Secondary	2,215	2000
Winslow WWTF	City of Winslow	Winslow	9,800	2,016	Ruby Wash		X					Adv. Tr. I	NA	2004

Notes:

NA: Data not currently available to ADWR

NRA: National Recreation Area

WWTF: Waste Water Treatment Facility

WWTP: Waste Water Treatment Plant

WRP: Water Reclamation Plant

SD: Sanitation District

ID: Improvement District

Adv. Tr. I: Advanced treatment level I

Adv. Tr. II: Advanced treatment level II

2.1.9 Water Adequacy Determinations in the Little Colorado River Plateau Basin

Water adequacy determination information including the subdivision name, location, number of lots, adequacy determination, reason for the inadequacy determination, date of determination and subdivision water provider are shown in Table 2-17. Figure 2-24 shows the location of subdivisions keyed to the Table. A description of the Adequacy Program is found in Volume 1, Appendix A. Briefly, developers of subdivisions outside of AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years. If the supply is determined to be inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents. Adequacy determination data sources and methods are found in Volume 1, Section 1.3.1.

- A total of 245 determinations of water adequacy have been made through May, 2005.
- 104 determinations of inadequacy have been made, primarily in the vicinity of Flagstaff, Show Low and Pinetop-Lakeside.
- The primary reason for a determination of inadequacy was insufficient data on physical and continuous water availability.
- The number of lots receiving an adequacy determination, by county, are:

County	Number of Subdivision Lots	Number of Lots Determined to be Adequate	Percent Adequate
Apache	4,387	2,973	68
Coconino	3,597	2,312	64
Navajo	7,750	5,187	67
Total	15,734	10,472	66

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
1	A-1 Ranch	Coconino	21 North	6 East	15	33	22-401052	Inadequate	A1, A2	05/07/04	A-1 Ranch Homeowners
2	Amity Estates	Apache	8 North	29 East	7	23		Adequate	---	12/02/76	Town of Eager
3	Anasazi Trails	Coconino	22 North	8 East	10, 15	17	22-401071	Inadequate	A1, A2	10/14/03	Doney Park Water Company
4	Apache Trails Unit One (amended)	Apache	10 North	24 East	11	94	22-400112	Inadequate	C	07/30/99	Cedar Grove Water Company
5	Arizona Rancheros, Rancho 36	Navajo	18 North	22 East	9	21	22-400335	Inadequate	C	06/28/00	Sun Valley Utilities
6	Arrowhead Estates	Coconino	21 North	7 East	9	8		Inadequate	A2, A3	08/08/88	Dry Lot Subdivision
7	Aspen Glen	Coconino	22 North	8 East	27	28	22-300069	Inadequate	A1	12/05/95	Doney Park Water Company
8	Aspen Shadows	Coconino	21 North	6 East	25	390	22-300242	Adequate	---	08/11/97	Flagstaff Ranch Water Company
9	Bar D Ranches	Coconino	22 North	8 East	23	15	22-400979	Inadequate	A1, A2	07/30/03	Doney Park Water Company
10	Bear Country Estates	Navajo	12 North	17 East	33	22	22-400036	Adequate	---	03/24/99	Arizona Water Company
11	Belair Estates	Apache	10 North	24 East	9	10		Inadequate	D	03/02/87	Belair Estates HOA
12	Benny Jay Heights	Apache	8 North	29 East	17	9	22-400431	Inadequate	A1	12/01/00	Town of Eager
13	Bent Oak	Navajo	8 North	23 East	2, 11	71		Adequate	---	06/21/89	Ponderosa DWID
14	Bison Cabin Resort II	Navajo	12 North	17 East	34	33	22-400516	Adequate	---	04/02/02	Arizona Water Company
15	Bison Ranch	Navajo	12 North	17 East	33	39	22-400080	Adequate	---	06/02/99	Arizona Water Company
16	Bison Ranch Resort Suites	Navajo	12 North	17 East	34	88	22-401659	Adequate	---	05/25/05	Arizona Water Company
17	Bison Ranch, Parcel C3	Navajo	12 North	17 East	34	22	22-400572	Adequate	---	09/21/01	Arizona Water Company
18	Bison Resort Cabins	Navajo	11 North	17 East	3	57	22-400257	Adequate	---	03/06/00	Arizona Water Company
19	Bison Resort Cabins III	Navajo	12 North	17 East	34	57	22-400691	Adequate	---	04/02/02	Arizona Water Company
20	Bison Town I (Parcels B1 & B2)	Navajo	12 North	17 East	33, 34	34	22-400447	Adequate	---	01/19/01	Arizona Water Company
21	Bison Town II (Parcels B3 & B4)	Navajo	12 North	17 East	33, 34	25	22-400446	Adequate	---	01/19/01	Arizona Water Company
22	Blue Ridge Estates	Coconino	15 North	12 East	32	193	22-300463	Adequate	---	06/12/98	Starlight Water Company
23	Blue Valley	Apache	8 North	29 East	16	8		Adequate	---	05/14/76	Town of Eager
24	Brewer Acres	Navajo	13 North	21 East	23	20		Adequate	---	11/03/75	Town of Snowflake
25	Burdon Ranch Estates	Navajo	11 North	22 East	25	131		Inadequate	A1	12/06/84	Dry Lot Subdivision
26	Bushman Acres	Navajo	13 North	21 East	26	48		Adequate	---	08/11/76	Town of Snowflake
27	Casitas of Pinetop	Navajo	9 North	23 East	32	28		Inadequate	A1	10/31/80	Pinetop Water Company
28	Cedar Ridge	Apache	8 North	29 East	10	49		Adequate	---	08/22/83	Town of Eager
29	Cedar Ridge #1	Apache	10 North	24 East	10	13		Inadequate	A1	11/06/91	Dry Lot Subdivision
30	Cedar Ridge #2	Apache	10 North	24 East	4	5		Inadequate	A1	07/09/87	Dry Lot Subdivision
31	Central Center	Navajo	10 North	22 East	20	10		Inadequate	A1	06/21/84	City of Show Low

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
32	Cheney Ranch	Navajo	10 North	21 East	8, 9	168		Adequate	---	04/17/86	White Mountain Water Company
33	Cholla Subdivision	Navajo	13 North	21 East	36	12		Adequate	---	03/04/81	Town of Taylor
34	Chu-Vista Estates	Navajo	12 North	22 East	30	NA		Inadequate	D	05/12/87	Dry Lot Subdivision
35	Cinder Forest Estates	Coconino	22 North	8 East	26, 27, 35, 36	82		Inadequate	A2	01/16/74	Dry Lot Subdivision
36	Cinder Mountain	Navajo	8 North	23 East	11	65		Adequate	---	09/17/73	Ponderosa Water Company
37	Circle G at Temple Hill Estates	Navajo	13 North	21 East	22	23	22-400715	Adequate	---	05/22/02	Town of Snowflake
38	Cobblecreek Development	Navajo	11 North	20 East	32	47		Adequate	---	05/12/87	Pinedale DWID
39	Concho Valley # 1B	Apache	12 North	26 East	18	21		Adequate	---	05/11/82	LIVCO Water Company
40	Concho Valley # 5A	Apache	12 North	26 East	19	108		Adequate	---	07/16/79	LIVCO Water Company
41	Concho Valley # 5B	Apache	12 North	26 East	19	192		Adequate	---	06/23/80	LIVCO Water Company
42	Concho Valley # 9	Apache	12 North	26 East	29	181		Adequate	---	08/23/89	LIVCO Water Company
43	Concho Valley # 9A	Apache	12 North	26 East	19	117		Adequate	---	05/23/91	LIVCO Water Company
44	Concho Valley # 10	Apache	12 North	26 East	7, 8	193		Adequate	---	05/23/91	LIVCO Water Company
45	Concho Valley # 12	Apache	12 North	26 East	8	303		Adequate	---	07/30/92	LIVCO Water Company
46	Concho Valley # 18	Apache	12 North	26 East	8, 9	203		Adequate	---	03/05/93	LIVCO Water Company
47	Concho Valley # 33	Apache	12 North	26 East	33	82		Adequate	---	01/15/85	LIVCO Water Company
48	Condominium at Pine Creek	Navajo	9 North	23 East	31	101		Inadequate	A1	10/03/86	Pinetop Water Company
49	Cool Water Acres	Navajo	17 North	19 East	12	25		Adequate	---	05/23/84	Dry Lot Subdivision
50	Cosnino Equestrian Estates	Coconino	21 North	9 East	7, 8	30		Adequate	---	08/28/73	Black Bill & Doney Park WUA
51	Cosnino Equestrian # 2	Coconino	21 North	9 East	8, 9	77		Adequate	---	03/21/79	Black Bill & Doney Park WUA
52	Cottonwood Ranch	Navajo	19 North	16 East	7	47		Inadequate	A1	06/19/85	Dry Lot Subdivision
53	Country Club Estates # 1	Navajo	13 North	21 East	21	18		Adequate	---	10/31/83	Town of Snowflake
54	Country Club Manor # 1	Navajo	10 North	21 East	14	60		Adequate	---	09/13/78	City of Show Low
55	Country Estates	Apache	8 North	29 East	10	20		Adequate	---	09/11/80	Town of Eager
56	Eagle Ridge	Apache	11 North	24 East	34	54	22-300464	Adequate	---	12/28/98	Cedar Grove Water Company
57	Eagle View Park	Coconino	22 North	8 East	10	11	22-401404	Inadequate	D	09/02/04	Doney Park Water Company
58	East Highland Estates	Navajo	13 North	21 East	23	49		Adequate	---	05/23/79	Town of Snowflake
59	East Valley Acres	Apache	8 North	29 East	2	12		Inadequate	A1	08/21/86	Town of Eager
60	El Rancho Grande	Navajo	12 North	21 East	6	46		Inadequate	A1	03/14/84	Dry Lot Subdivision
61	Elk Crest Estates	Apache	8 North	29 East	18	72	22-400164	Inadequate	A1	11/30/99	Town of Eager
62	Elk Meadow	Apache	6 North	29 East	1	8		Adequate	---	05/30/89	Elk Meadow HOA

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
63	Elkins Acres	Navajo	10 North	21 East	24	51	22-401991	Inadequate	A1	08/18/03	Park Valley Water Company
64	Escondido	Apache	8 North	29 East	7, 8	48		Adequate	---	08/22/79	Town of Eager
65	Escondido # 2 (amended)	Apache	8 North	29 East	18	57		Adequate	---	05/21/82	Town of Eager
66	Escudilla Mountain Estates Units 1, 2 & 3	Apache	7 North	30 East	31	74	22-300583	Inadequate	A1	12/15/98	Dry Lot Subdivision
67	Evergreen Estates Unit I	Navajo	9 North	22 East	4	24	22-400725	Inadequate	A1	05/22/02	Pineview Water Company
68	Fairway Park Center	Navajo	10 North	21 East	23	26		Adequate	---	09/24/76	Fairway Park
69	Foothills # 2	Apache	8 North	29 East	9	36		Adequate	---	12/21/79	Town of Eager
70	Forest Trails # 1	Navajo	12 North	17 East	28	170		Adequate	---	07/20/84	Arizona Water Company
71	Forest Trails # 2	Navajo	12 North	17 East	28	207		Adequate	---	05/13/85	Arizona Water Company
72	Forest Trails # 3B	Navajo	12 North	17 East	28	49	22-300004	Adequate	---	04/03/95	Arizona Water Company
73	Fort Valley Meadows-Lots 56-65	Coconino	22 North	6 East	26	10	22-400139	Inadequate	A2	07/30/99	Community well
74	Fort Valley Pines	Coconino	22 North	6 East	34	11	22-400898	Inadequate	A1	03/12/03	Dry Lot Subdivision
75	Frontier Estates	Navajo	13 North	21 East	22	202	22-400564	Adequate	---	08/30/01	Town of Snowflake
76	Frontier Hills	Coconino	22 North	8 East	24	33		Inadequate	A1, A2	05/04/94	Doney Park Water Company
77	G Flake Subdivision	Navajo	13 North	21 East	22	NA	22-400583	Adequate	---	09/28/01	Town of Snowflake
78	Gobbler Peak Estates	Apache	6 North	29 East	1	28		Adequate	---	10/24/91	Dry Lot Subdivision
79	Golden Lockett	Coconino	21 North	7 East	3	14	22-400951	Inadequate	A1, A2	05/23/03	NA
80	Grand View Estates # 1	Apache	8 North	29 East	18	58		Adequate	---	07/26/82	Town of Eager
81	Green Valley Acres	Apache	8 North	29 East	16	198		Adequate	---	02/26/75	Town of Eager
82	Green Valley Ranches	Navajo	11 North	22 East	6	22		Adequate	---	09/01/76	Subdivision wells
83	Greer Acres	Apache	7 North	27 East	2	14	22-400209	Inadequate	A1	12/08/99	Dry Lot Subdivision
84	Greer Lodge Estates	Apache	7 North	27 East	14	16		Adequate	---	09/13/94	Greer Meadows HOA
85	Greer Mountain Subdivision	Apache	7 North	27 East	14	24		Adequate	---	07/11/95	Greer Mountain Subdivision Joint Venture
86	Greer View Estates	Apache	7 North	27 East	12	22	22-400001	Adequate	---	03/04/99	Dry Lot Subdivision
87	Hacienda Pines-Unit 1	Navajo	10 North	21 East	25	68	22-300448	Adequate	---	04/23/98	City of Show Low
88	Harvest Valley	Navajo	12 North	21 East	5	10		Adequate	---	02/24/76	Dry Lot Subdivision
89	Hidden Meadow Ranch	Apache	9 North	27 East	30	52	22-400654	Inadequate	B	05/13/02	Club at Hidden Ranch HOA
90	High Country Pines II - Unit I	Navajo	12 North	16 East	15	n/a	22-300405	Adequate	---	01/08/98	High Country Pines Water Company
91	High Country Pines II - Unit 2	Navajo	12 North	16 East	15	74	22-400127	Adequate	---	07/21/99	High Country Pines Water Company
92	High Country Pines Inc.	Navajo	12 North	16 East	15	142		Adequate	---	04/26/85	High Country Pines Water Company
93	Highland Park-Unit 5, Phase 1	Navajo	13 North	21 East	26	12	22-300161	Adequate	---	06/24/96	Town of Snowflake

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
94	Hillcrest	Apache	8 North	29 East	3, 4	36		Adequate	---	01/29/76	Town of Eager
95	Homestead at Torreon-Unit 1	Navajo	10 North	21 East	25, 26	109	22-300437	Adequate	---	03/31/98	City of Show Low
96	Hutchinson Acres	Coconino	22 North	8 East	9, 16	95	22-400459	Inadequate	A1	03/23/01	Doney Park Water Company
97	J. L. Subdivision	Apache	8 North	29 East	4	11		Adequate	---	07/23/76	Town of Eager
98	Koch Field East	Coconino	22 North	8 East	25	10		Inadequate	A2	04/26/93	Doney Park Water Company
99	Laguna Estates # 1	Navajo	11 North	22 East	25	151		Inadequate	A1	07/07/86	High Country Water
100	Linden Trails	Navajo	10 North	21 East	3, 4	96	22-401605	Adequate	---	03/16/05	Mountain Glen Water Service
101	Lockett Estates	Coconino	21 North	7 East	4	16	22-400415	Inadequate	A1, A3	11/13/00	Community well
102	Mahogany Run Subdivision	Coconino	21 North	7 East	3, 4	7	22-400716	Inadequate	A3	05/21/02	Dry Lot Subdivision
103	Majestic Views Estates	Coconino	22 North	6 East	26	28	22-401616	Inadequate	A1	01/12/05	Majestic Views DWID
104	Mogollon Airpark	Navajo	12 North	17 East	33	27		Adequate	---	01/03/86	Arizona Water Company
105	Mogollon Airpark # 3	Navajo	12 North	17 East	33	59		Adequate	---	05/15/87	Arizona Water Company
106	Mogollon Airpark # 4A	Navajo	12 North	17 East	34	52		Adequate	---	10/06/93	Arizona Water Company
107	Mogollon Air Park # 4B	Navajo	12 North	17 East	27, 34	36		Adequate	---	04/06/94	Arizona Water Company
108	Mogollon Airpark # 6	Navajo	12 North	17 East	27, 34	52	22-300042	Adequate	---	07/25/95	Arizona Water Company
109	Mogollon Airpark Properties	Navajo	12 North	17 East	33	54		Adequate	---	03/06/85	Arizona Water Company
110	Mogollon Estates	Navajo	12 North	17 East	27, 34	70	22-300167	Adequate	---	07/15/96	Arizona Water Company
111	Mountain Pine Ranch- Unit I	Apache	10 North	24 East	5	57		Inadequate	A1	04/13/93	Dry Lot Subdivision
112	Mountain Pine Ranch-Unit II	Apache	10 North	24 East	5	57	22-400107	Inadequate	A1	06/29/99	Dry Lot Subdivision
113	Mountain Pines Estates	Navajo	8 North	23 East	2	86		Adequate	---	09/01/83	Ponderosa Water Company
114	Mountain View	Apache	12 North	28 East	4	55		Adequate	---	12/30/76	Mountain View Water Company
115	Mountain View # 2	Apache	12 North	28 East	4	32		Adequate	---	08/18/78	Mountain View Water Company
116	Mountain View Ranchos	Coconino	21 North	9 East	6	28		Adequate	---	07/19/73	Subdivision wells
117	Needles Creek Subdivision	Navajo	10 North	21 East	13	57	22-400451	Inadequate	A1	01/19/01	Fools Hollow Water Company
118	Nicoll Subdivision	Apache	8 North	29 East	9	20		Adequate	---	02/06/80	Town of Eager
119	Noble Mountain Estates (amended)	Apache	6 North	30 East	7	65		Inadequate	A1	07/26/94	Dry Lot Subdivision
120	North Peak	Coconino	22 North	8 East	28, 29	18		Inadequate	A2	01/24/92	Doney Park Water Company
121	North Peak # 2	Coconino	22 North	8 East	28	11		Inadequate	A2	02/23/93	Doney Park Water Company
122	Northern Taylor	Navajo	13 North	21 East	36	14		Adequate	---	08/15/77	Town of Taylor
123	Northfork Ranches # 1	Apache	10 North	24 East	7	93		Inadequate	A1	04/10/85	Dry Lot Subdivision
124	Ojo Bonito Estates	Apache	10 North	25 East	19	63		Adequate	---	09/10/81	Ojo Bonito HOA

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
125	Park Place	Navajo	10 North	21 East	24	78	22-300341	Inadequate	A1	08/15/97	Park Valley Water Company
126	Park Place III	Navajo	10 North	21 East	24	35	22-400331	Inadequate	A1	07/17/00	Park Valley Water Company
127	Park Place IV	Navajo	10 North	21 East	24	16	22-401172	Inadequate	A1	01/12/04	Park Valley/Fool Hollow Water Company
128	Park Plaza # 1	Navajo	13 North	21 East	21	31		Adequate	---	05/23/86	Town of Snowflake
129	Park Show Low # 1	Apache	10 North	24 East	1	20		Inadequate	A1	06/22/94	Dry Lot Subdivision
130	Park Show Low # 1-4	Apache	10 North	24 East	1	140		Inadequate	A1	11/06/91	Dry Lot Subdivision
131	Park Show Low # 3, 4	Apache	11 North	24 East	1, 11	47		Inadequate	A1	06/22/94	Dry Lot Subdivision
132	Park Show Low # 4,5,6	Apache	11 North	24 East	1, 13, 15	62		Inadequate	A1	12/22/86	Dry Lot Subdivision
133	Park Valley # 3	Navajo	10 North	21 East	24	86		Inadequate	A1	10/05/83	Park Valley Water Company
134	Park Valley # 4	Navajo	10 North	21 East	25	189		Inadequate	A1	10/08/86	City of Show Low
135	Petrified Forest Estates # 2	Apache	18 North	24 East	5	133		Inadequate	C	01/14/87	Dry Lot Subdivision
136	Pine Canyon Estates	Coconino	14 North	12 East	6	385	22-300466	Adequate	---	06/24/98	Starlight Water Company
137	Pine Meadows Country Club Estates	Navajo	12 North	17 East	33	116		Adequate	---	05/30/86	Arizona Water Company
138	Pine Mountain Estates	Coconino	22 North	8 East	9	36	22-300065	Inadequate	A1	12/05/95	Doney Park Water Company
139	Pine Oaks	Navajo	10 North	22 East	29	78	22-300200	Inadequate	A1	09/27/96	City of Show Low
140	Pine Ridge # 1	Navajo	8 North	23 East	4, 5	73		Inadequate	A1	01/08/86	Pinetop Water Company
141	Pine Rim Forest	Navajo	12 North	17 East	30	56		Inadequate	A1	09/01/83	Arizona Water Company
142	Pineaire	Navajo	10 North	22 East	32	160		Adequate	---	10/25/73	Pineview Water Company
143	Pinecrest Lake	Navajo	12 North	17 East	33	200		Adequate	---	08/05/86	Arizona Water Company
144	Pineglen Park	Navajo	9 North	22 East	4	94		Inadequate	A1	12/05/83	Pineview Land and Water Company
145	Pineglen Village # 1	Navajo	9 North	22 East	4	84		Inadequate	A1	12/05/83	Pineview Land and Water Company
146	Pinegrove Park	Navajo	10 North	21 East	24	37		Inadequate	A1	08/10/83	Park Valley Water Company
147	Pines at Show Low Condominiums	Navajo	10 North	22 East	32	132		Adequate	---	02/18/87	Pineview Water Company
148	Pinetop Country Club Village	Navajo	8 North	23 East	11	n/a		Adequate	---	09/17/73	Ponderosa Water Company
149	Pinetop Lakes Plaza # 2, 3	Navajo	8 North	23 East	2	53		Adequate	---	10/06/83	Ponderosa Water Company
150	Pinetop Lakes, Mountain Homes	Navajo	8 North	23 East	11	111		Adequate	---	02/06/74	Ponderosa Water Company
151	Pioneer Subdivision	Apache	8 North	29 East	4	20		Adequate	---	06/08/81	Town of Eager
152	Pioneer Valley # 1	Coconino	22 North	8 East	14, 23	35		Inadequate	A2	12/04/92	Doney Park Water Company
153	Pioneer Valley # 3, 2B	Coconino	22 North	8 East	23	83		Inadequate	A2	10/03/94	Doney Park Water Company
154	Randall	Navajo	18 North	19 East	15	36		Adequate	---	09/06/73	Joseph City Water Company
155	Rendezvous at Torreon-Unit 1	Navajo	10 North	21 East	23	113	22-300436	Adequate	---	03/31/98	City of Show Low

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
156	Rim Rock View Estates Unit 1	Navajo	13 North	21 East	22	8	22-400642	Adequate	---	01/03/02	Subdivision wells
157	Rim Spur	Navajo	9 North	22 East	27	11	22-400368	Inadequate	C	08/30/00	Dry Lot Subdivision
158	Rim Top Ranch	Coconino	15 North	12 East	21, 27, 35	211	22-300542	Inadequate	D	09/21/99	HOA Wells
159	Rio Rancho Estates	Coconino	22 North	8 East	35, 36	37	22-400499	Inadequate	A1	03/26/01	Doney Park Water Company
160	Rio Vista Estates	Apache	21 North	28 East	13	34	22-401474	Inadequate	A1	11/03/04	Navajo Tribal Utility Authority
161	River Run Estates	Apache	8 North	29 East	4	214	22-400290	Inadequate	A1	04/13/00	Town of Eager
162	Rolling Hills # 2	Navajo	12 North	21 East	3	49		Adequate	---	03/12/74	Town of Taylor
163	Roundhouse Square # 2	Navajo	8 North	23 East	2	9		Adequate	---	03/31/76	Ponderosa Water Company
164	San Juan Meadows	Apache	13 North	27 East	25, 26	15	22-300370	Adequate	---	10/31/97	Dry Lot Subdivision
165	Saskan Ranch	Coconino	21 North	6 East	23, 24	14		Inadequate	D	08/31/94	HOA Wells
166	Satellite Homestead	Navajo	11 North	22 East	25	131		Adequate	---	05/13/75	Silver Well Service Corporation
167	Scotts Pine Meadows	Navajo	9 North	22 East	9	27		Inadequate	A1	02/11/86	Pineview Land and Water Company
168	Shadowing Pines	Navajo	8 North	23 East	5	112		Adequate	---	12/16/74	Pinetop Water Company
169	Show Low Golf & Country Club	Navajo	10 North	21 East	23	NA		Adequate	---	07/01/75	City of Show Low
170	Show Low Vista Community-Unit 1A	Navajo	10 North	22 East	18	20	22-300490	Adequate	---	07/08/98	City of Show Low
171	Sierra Pines	Navajo	10 North	22 East	30	57	22-300054	Adequate	---	10/19/95	City of Show Low
172	Sierra Pines Unit 2	Navajo	10 North	22 East	30	61	22-300198	Inadequate	A1	09/19/96	City of Show Low
173	Sierra Pines Unit 3	Navajo	10 North	22 East	29, 30	39	22-300379	Adequate	---	10/15/97	City of Show Low
174	Sierra Pines Unit 4	Navajo	10 North	22 East	30	49	22-300501	Adequate	---	07/21/98	City of Show Low
175	Sierra Vista Ranchettes	Navajo	19 North	15 East	1	20		Adequate	---	06/05/86	Dry Lot Subdivision
176	Silver Creek Village	Navajo	11 North	22 East	15	35		Inadequate	A1	02/04/85	White Mountain Lake Water Company
177	Silver Creek Waterfront Estates	Navajo	11 North	22 East	10, 11	99	22-400262	Adequate	---	03/20/00	White Mountain Lakes Estates Utility
178	Silver Lake Estates # 1 & 2	Navajo	11 North	22 East	35	12	22-300146	Inadequate	C	07/25/96	Silver Well Service Corporation
179	Skyline Estates	Coconino	22 North	9 East	19	9	22-401403	Inadequate	D	09/02/04	Doney Park Water Company
180	Slayton Ranch Estates	Coconino	22 North	8 East	13, 24	117	22-401149	Inadequate	A1, A2	12/22/03	Doney Park Water Company
181	Snowbase	Coconino	22 North	6 East	26	55	22-300287	Inadequate	A1	06/04/97	Dry Lot Subdivision
182	Snowbowl Ranch	Coconino	22 North	6 East	23	15		Inadequate	A1, A2	08/24/94	Dry Lot Subdivision
183	Snowflake Country Club	Navajo	13 North	21 East	21	57		Adequate	---	06/04/80	Town of Snowflake
184	Snowflake Country Club Properties	Navajo	13 North	21 East	21	80	22-400563	Adequate	---	08/20/02	Town of Snowflake
185	Snowflake East # 1	Navajo	13 North	22 East	3	27		Inadequate	A1	08/09/85	Dry Lot Subdivision
186	Snowflake Garden Estates	Navajo	13 North	21 East	14	47		Adequate	---	07/08/74	Town of Snowflake

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
187	Snowflake Heights	Navajo	13 North	22 East	17	90		Adequate	---	01/27/84	Town of Snowflake
188	Snowflake Heights # 2	Navajo	13 North	22 East	17	131		Adequate	---	06/06/84	Town of Snowflake
189	Stardust Meadows	Coconino	22 North	8 East	24	9	22-300002	Inadequate	A1	04/10/95	Doney Park Water Company
190	Starlight Pines # 1	Coconino	15 North	12 East	31	154		Adequate	---	05/23/83	United Utilities Company
191	Starlight Pines #2	Coconino	15 North	12 East	31	176		Adequate	---	04/24/86	Mogollon Water Company
192	Starlight Pines # 3	Coconino	15 North	12 East	31	n/a		Adequate	---	10/24/86	Mogollon Water Company
193	Starlight Pines # 4	Coconino	15 North	12 East	31	248		Adequate	---	11/09/88	Mogollon Water Company
194	Starlight Pines # 5	Coconino	15 North	12 East	31	17		Adequate	---	02/09/95	Starlight Water Company
195	Starlight Pines Ranchettes	Coconino	14 North	12 East	7	125	22-300093	Adequate	---	07/30/96	Starlight Water Company
196	Starlight Ridge Estates-Unit 1	Navajo	9 North	22 East	8	48	22-401400	Inadequate	D	07/20/04	Pineview Water Company
197	Starwood Estates	Navajo	8 North	23 East	1	65	22-400300	Inadequate	D	05/03/00	Ponderosa DWID
198	Summer Meadows	Apache	8 North	29 East	4	17		Adequate	---	06/08/81	Town of Eager
199	Summer Meadows #3	Apache	8 North	29 East	4	7		Inadequate	A1	08/21/86	Town of Eager
200	Summer Place	Navajo	12 North	16 East	24	36		Adequate	---	10/08/85	Arizona Water Company
201	Summer Place North	Navajo	12 North	16 East	24	45	22-300369	Adequate	---	11/17/97	Arizona Water Company
202	Summer Place North-Unit 2	Navajo	12 North	16 East	24	40	22-400412	Adequate	---	11/17/00	Heber DWID
203	Sun Valley Highlands # 2	Navajo	18 North	22 East	5	58	22-300308	Inadequate	A1	06/03/97	Dry Lot Subdivision
204	Sundance Springs Community	Navajo	13 North	21 East	13	257	22-401743	Adequate	---	08/04/05	Snowflake Municipal Water Company
205	Sunrise Vista Estates	Apache	10 North	24 East	9	24		Adequate	---	10/26/93	Cedar Grove Water Company
206	Sunset Vista Estates	Coconino	22 North	8 East	31	24	22-300390	Inadequate	A1	12/10/97	Doney Park Water Company
207	Tall Pine Estates # 2	Coconino	18 North	9 East	28	44		Inadequate	A1	08/10/89	Tall Pines Estates Water & Improvement
208	Tamarron Pines	Coconino	15 North	12 East	32	411	22-400100	Adequate	---	07/02/99	Starlight Water Company, Inc.
209	The Village	Navajo	10 North	21 East	24	17	22-401373	Inadequate	D	08/04/04	Park Valley Water Company.
210	Thunder Run Estates	Navajo	12 North	17 East	30	41	22-400132	Adequate	---	07/28/99	Arizona Water Company
211	Timberline Estates # 3	Coconino	22 North	8 East	9	10		Inadequate	A2	10/03/89	Doney Park Water Company
212	Timberline Estates-Unit 4	Coconino	22 North	8 East	9	25	22-400187	Inadequate	A1, A2	10/20/99	Doney Park Water Company
213	Town and Country # 1	Navajo	18 North	19 East	15	33		Adequate	---	05/07/79	Joseph City Utility Company
214	Udall Estates	Apache	8 North	29 East	7, 18	37		Adequate	---	12/05/83	Town of Eager
215	United Estates # 1	Navajo	12 North	17 East	30	35		Adequate	---	05/23/79	Arizona Water Company
216	Valley View Estates	Apache	8 North	29 East	8	11		Adequate	---	09/01/76	Town of Eager
217	Valley View Estates	Navajo	13 North	21 East	26	49		Adequate	---	09/26/77	Town of Snowflake

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						
218	Valley View Estates # 2	Apache	8 North	29 East	8	21		Adequate	---	07/26/82	Town of Eager
219	Vein of Gold-Unit IV	Navajo	18 North	22 East	5, 8	332	22-300309	Inadequate	A1	06/03/97	Dry Lot Subdivision
220	Vernon Valley II	Apache	10 North	25 East	22	28		Adequate	---	10/15/86	Serviceberry Water Company
221	Vista San Juan # 1	Apache	13 North	28 East	31	45		Adequate	---	12/06/76	Developer water company
222	Wenima Village Project	Apache	9 North	29 East	8, 17, 18	221		Adequate	---	05/17/89	Town of Springerville
223	West Gardens	Navajo	13 North	21 East	16	43		Adequate	---	12/09/76	Town of Snowflake
224	West Peak	Coconino	21 North	6 East	23, 24	12		Inadequate	A2, A3	08/11/94	Dry Lot Subdivision
225	West View Subdivision	Navajo	13 North	21 East	23	12	22-401498	Adequate	---	01/18/05	Town of Snowflake
226	Westbrook Addition-Vernon Townsite	Apache	10 North	25 East	21	8	22-400494	Adequate	---	04/18/01	Vernon DWID
227	Westwood Estates	Coconino	21 North	6 East	23	78	22-300012	Adequate	---	06/21/95	Flagstaff Ranch Water Company
228	Whispering Pines Townhouses	Navajo	9 North	23 East	31	89		Inadequate	A1	07/03/84	Pinetop Water Company
229	White Mountain Lakes #1 8	Navajo	11 North	22 East	10, 14, 15	132		Inadequate	A1	09/27/84	White Mountain Lake Water Company
230	White Mountain Lakes Estates	Navajo	11 North	22 East	3, 4, 10, 11, 12, 13, 14, 23, 24	NA		Adequate	---	06/27/85	White Mountain Lakes Estates Utility
231	White Mountain Resort	Apache	9 North	24 East	17	54	22-300007	Inadequate	A1	06/16/95	Dry Lot Subdivision
232	White Mountain Vacation Village	Navajo	10 North	22 East	32, 33	117	22-400626	Inadequate	A1	11/08/01	Pineview Water Company
			9 North	22 East	4, 5,			Inadequate	A1		
233	White Mountain Vacation Village Unit 2, Phase 3	Navajo	9 North	22 East	4	7	22-401415	Inadequate	A1	08/15/04	Pineview Water Company
234	Wilderness	Apache	10 North	24 East	12	115		Adequate	---	07/10/91	Lord Arizona Water Systems
235	Winchester Trails Ranches	Apache	10 North	25 East	17	135		Adequate	---	03/03/87	Lord Arizona Water Systems
236	Winchester Trails Ranches # 2	Apache	10 North	25 East	17	68		Inadequate	C	01/28/85	Dry Lot Subdivision
237	Wing Mountain Ranch-Unit 1	Coconino	22 North	6 East	27	16		Inadequate	A1	04/11/90	Dry Lot Subdivision
238	Wing Mountain Ranch-Unit 2	Coconino	22 North	6 East	27	15		Inadequate	A1	07/07/92	Dry Lot Subdivision
239	Wing Mountain Ranch-Unit 3	Coconino	22 North	6 East	27	15	22-300534	Inadequate	A1, A2	09/22/98	Dry Lot Subdivision
240	Wing Mountain Ranch Unit 3, Phase 2	Coconino	22 North	6 East	27	15	22-401217	Inadequate	A1	03/02/04	Dry Lot Subdivision
241	Wolf Pines-Unit 1	Navajo	9 North	22 East	9	26	22-400565	Inadequate	A1	10/02/02	Pineview Water Company
242	Woodland Acres	Navajo	12 North	17 East	33	19	220400043	Adequate	---	03/24/99	Arizona Water Company
243	Woodland Hills Subdivision	Navajo	8 North	23 East	6	152	22-300514	Inadequate	A1, C	08/27/98	Pinetop Water Company
244	Wupatki Trails	Coconino	23 North	8 East	29, 32, 33	41	22-400517	Inadequate	A1	05/14/01	Doney Park Water Company
245	Wye Subdivision	Apache	8 North	29 East	11	18		Adequate	---	08/22/83	Town of Eager

Notes:

¹Each determination of the adequacy of water supplies available to a subdivision is based on the information available to ADWR and the standards of review and policies in effect at the time the determination was made. In some cases, ADWR might make a different determination if a similar application were submitted today, based on the hydrologic data and other information currently available, as well as current rules and policies.

Table 2-17 Adequacy Determinations in the Little Colorado River Plateau Basin¹

Map Key	Subdivision Name	County	Location			No. of Lots	ADWR File No. ²	ADWR Adequacy Determination	Reason(s) for Inadequacy Determination ³	Date of Determination	Water Provider at the Time of Application
			Township	Range	Section						

² Prior to February 1995, ADWR did not assign file numbers to applications for adequacy determination.

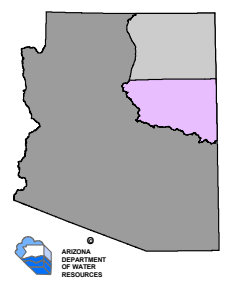
³ A. Physical/Continuous

- 1) Insufficient Data (applicant chose not to submit necessary information, and/or available hydrologic data insufficient to make determination)
 - 2) Insufficient Supply (existing water supply unreliable or physically unavailable;for groundwater, depth-to-water exceeds criteria)
 - 3) Insufficient Infrastructure (distribution system is insufficient to meet demands or applicant proposed water hauling)
- B. Legal (applicant failed to demonstrate a legal right to use the water or failed to demonstrate the provider's legal authority to serve the subdivision)
- C. Water Quality
- D. Unable to locate records

DWID = Domestic Water Improvement District

NA = Data not currently available to ADWR

R10E	R12E	R14E	R16E	R18E	R20E	R22E	R24E	R26E	R28E	R30E
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SECTION 2.2 Water Resource Issues in the Eastern Plateau Planning Area

A number of water resource issues have been identified in the planning area by community groups, through the distribution of surveys, and from other sources. Primary issues are the accessibility of groundwater supplies in some areas due to hydrologic conditions and water quality problems. There are also infrastructure deficiencies that influence access to water supplies. A number of communities lack financial resources for infrastructure development or repair and drought has impacted surface water supplies. The ability to meet future water demands is a concern for many communities. Many Navajo communities currently face critical water shortages. Water hauling is commonplace on the reservation, in part because widely scattered housing makes direct water delivery impractical in many areas. Hauling is also common at some locations outside of the reservation.

Several watershed groups have formed in the Eastern Plateau Planning Area to address a variety of water resource issues. Some groups encompass areas outside of the Eastern Plateau Planning Area. Groups that are currently active in various locations within the basin are the Coconino Plateau Advisory Council, Northern Arizona Municipal Water Users, Little Colorado Watershed Coordinating Council (formerly the Little Colorado River Multi-Objective Management Partnership (LCRMOM)), Show Low Creek Watershed Partnership, the Silver Creek Watershed Partnership, the Upper Little Colorado River Watershed Partnership and the Navajo Nation. A complete description of participants, activities and issues is found in Appendix B. Primary issues identified by these groups that apply to the Eastern Plateau Planning area can be summarized as follows:

Growth:

- Excessive growth in some areas
- Proposed development in Greer and impacts on the Little Colorado River
- Unregulated lot splits

Water Supplies and Demand:

- Limited and deep groundwater supplies
- Drought sensitive supplies
- Numerous water haulers and few hauling stations which are sometimes cutoff during drought
- Limited surface water supplies for Page
- Limited groundwater data for entire region
- Potential impacts on groundwater system from power plants
- Seasonal demands impacting ability to meet peak demands

Legal:

- Potential limitation of groundwater usage resulting from Indian reserved groundwater rights
- Uncertainty of Indian water right settlements (Little Colorado River & Colorado River)
- Access to water development activities on public lands
- Competition from Phoenix/Tucson for CAP reallocation water
- Upper Basin/Lower Basin Colorado River issues affecting potential for use
- Unresolved surface water adjudication

Water Quality:

- Minor arsenic issues in Woody Mtn. Well field (9-14 ppb)
- Arsenic and TDS in some areas

Environmental:

- Endangered Species Act implications on groundwater usage and impacts on perennial streams

- Impact of invasive species (Tamarisk)

Funding:

- Limited funding resources for planning, projects, infrastructure and studies
- Extremely high cost of water augmentation projects
- Funding for Colorado River water infrastructure
- Funding for water delivery infrastructure

Drought:

- Drought impacts on surface water supplies and springs resulting in impacts on agriculture and cattle ranching
- Potential impacts on tourism due to drought

Other:

- Political differences between some communities
- Perception of no real water supply problem
- Several high hazard unsafe dams

Potential future and current water supply shortfalls have lead to discussions among the Coconino Plateau Advisory Council regarding water supply development/augmentation alternatives. Among the proposed alternatives is a water pipeline from Lake Powell to communities in both the Eastern and Western Plateau Planning Areas (Heffernon and Muro, 2001). A study to identify potential supply alternatives for the area was completed by the Bureau of Reclamation in 2005 and an appraisal level is expected to be completed in 2006.

The Department conducted a rural water resources survey in 2003 to compile information to provide to the public and help identify the needs of growing communities. This survey was also intended to gather information on drought impacts to incorporate into the Arizona Drought Preparedness Plan, adopted in 2004. Questionnaires were sent to almost 600 water providers, jurisdictions, counties and tribes. A report of the findings from the survey was completed in 2004 (ADWR, 2004).

Thirty-seven water providers and jurisdictions in the Eastern Plateau Planning Area responded to the survey and of these, 23 ranked issues. Respondents were asked to rank eighteen issues which can be compressed into three categories: infrastructure, water supply and water quality. In the planning area, both infrastructure and water supply issues were ranked among the top five issues by a majority of respondents. In addition, a majority of respondents noted at least one drought impact. Primary drought impacts noted were increased demand, increased peak demand and lowered groundwater levels.

The Department conducted another, more concise survey of water providers in 2004. This was done to supplement the information gathered in the previous year in support of developing the Arizona Water Atlas, and to reach a wider audience by directly contacting each water provider. Through this effort, 44 water providers in the Eastern Plateau Planning Area, with a total of approximately 46,500 service connections, were willing to participate and provide information on water supply, demand, infrastructure and to rank a list of seven issues.

In regard to the question of groundwater level trends in their service area, the 33 respondents reported as follows: 20 stable; 8 falling, 3 don't know, 2 variable. None reported rising water levels.

Water providers were asked to rank issues from 0 to 4 with 0 = no concern, 1 = minor concern, 2 = moderate concern and 3 = major concern. Of the 44 water providers that responded to the survey, 39 ranked issues. These respondents include most of the largest water providers in the planning area

including City of Flagstaff, City of Holbrook, City of Show Low, Town of Snowflake, Winslow Municipal Water and Doney Park Water Company.

Table 2-18 Water resource issues ranked by 2004 survey respondents in the Eastern Plateau Planning Area (39 water providers)

Issue	Moderate concern	Major concern	Total	Percent of respondents reporting issue was a moderate or major concern
Inadequate storage capacity to meet peak demand	6	6	12	31
Inadequate well capacity to meet peak demand	7	4	11	28
Inadequate water supplies to meet current demand	4	1	5	13
Inadequate water supplies to meet future demand	9	3	12	31
Infrastructure in need of replacement	11	8	19	49
Inadequate capital to pay for infrastructure improvements	10	12	22	56
Drought related water supply problems	6	4	10	26

Although responses to the 2003 questionnaire are not directly comparable to the 2004 survey due to differences in the form and wording of the surveys, responses to the same issues are similar as shown in Table 2-19.

Table 2-19 Water resource issues ranked by 2003 survey respondents in the Eastern Plateau Planning Area (17 water providers and 6 jurisdictions)

Issue	Ranked as one of the top 5 issues (of 18)	Percent of respondents
Inadequate storage capacity to meet peak demand	9	39
Inadequate well capacity to meet peak demand	6	26
Inadequate water supplies to meet current demand	4	17
Inadequate water supplies to meet future demand	9	39
Infrastructure in need of replacement	13	52
Inadequate capital to pay for infrastructure improvements	10	43
Drought related water supply problems	8	35

Tribal Issues

A Navajo Department of Water Resources (NDWR) White Paper identified the need for an increased water supply to help support needed basic services on the reservation (NDWR, 2002). The tribe is investigating the feasibility of transporting water by pipeline to several areas and is conducting groundwater development investigations. NDWR, USBR and BIA have cooperated on a plan to investigate the alluvial aquifer in the Bird Springs area located east of Leupp at the southern edge of the Navajo Reservation Boundary northwest of Winslow, to analyze the feasibility of well field development (NDWR, 1999).

One of the water development challenges on the Navajo reservation is that resolution of problems requires the coordination of multiple agencies and private resources. In addition, the population has limited economic resources that make large capital investments difficult and the widely dispersed population results in large distances between water sources and water users. Although the Navajo Nation has adopted a Drought Plan and conducts numerous planning activities, additional regional water planning, investigation of a regional conveyance system, improving water service to domestic water haulers and water conservation and reuse were also identified as needs (NDWR, 2002)

The Hopi and Navajo are concerned about the impact to their water supply by Peabody Coal Company extracting N-aquifer water to transport coal from the Black Mesa Coal Mine to the Mohave Generating Station at Laughlin, Nevada. The N-aquifer is the only source of drinking water for the Hopi. This pumping is believed to be affecting water supplies in some areas (www.hopi.nsn.us). The USGS, in cooperation with the Bureau of Reclamation, is evaluating the C-aquifer near Leupp on the Navajo Reservation for potential use as a water supply for Peabody Coal and for the Navajo and Hopi (USGS, 2005). The Hopi tribe has recently purchased off-reservation ranches near Winslow and Springerville for potential irrigation development or other purposes (www.hkminc.com/Hopi.htm).

Resolution of Indian water rights settlements is a critical issue in the planning area. The Navajo Nation, Hopi Tribe, Zuni Tribe and the San Juan Southern Piaute Tribe have been negotiating with non-Indian water users in the Little Colorado River Plateau basin, the State of Arizona and the federal government for several years in a settlement committee appointed by the Little Colorado General Stream Adjudication Court.

The non-Indian parties reached agreement with the Zuni Tribe over protection of its Zuni Heaven lands in Arizona, resulting in congressional approval in 2003. Talks in a less formal setting have continued with the Navajo Nation and Hopi Tribe about possible settlement of the Little Colorado River Basin claims. Additionally, the Navajo Nation filed a lawsuit in April of 2003 against the Secretary of the Interior over the operation of the Colorado River. A Federal judge has entered a stay in that case to allow negotiations with the State of Arizona and non-Indian water users about possible Navajo Nation claims to the Colorado River.

REFERENCES AND FURTHER READING

A

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- ACC, 2005, Annual reports for years 1990 to 2005 for small water providers: ACC Utilities Division, July 2005.
- ADEQ, 2005, ADEQSWI Database: ADEQ data file, received September 2005.
- ADEQ, 2005, ADEQWATP Database: ADEQ data file, received August 2005.
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ACRONYMS AND ABBREVIATIONS

A.R.S.	Arizona Revised Statutes
ADEQ	Arizona Department of Environmental Quality
AF	Acre-feet
AGFD	Arizona Game and Fish
ALERT	Automated Local Evaluation in Real Time
ALRIS	Arizona Land Resource Information System
AMA	Active Management Area
ASLD	Arizona State Land Department
AWPF	Arizona Water Protection Fund
AWS	Assured Water Supply
AZMET	Arizona Meteorological Network
BIA	Bureau of Indian Affairs (U.S.)
BLM	Bureau of Land Management (U.S.)
BOR	Bureau of Reclamation (U.S.)
CAP	Central Arizona Project
CDP	Census Designated Place
CLIMAS	Climate Assessment for the Southwest
CODE	Arizona Groundwater Management Act - A.R.S. § 45-401 <i>et seq.</i>
COE	Corps of Engineers (U.S.)
Department/ADWR	Arizona Department of Water Resources
ENSO	El Nino/Southern Oscillation
EPA	Environmental Protection Agency (U.S.)
ESA	Endangered Species Act - 7 U.S.C. 136; 16 U.S.C. 460 <i>et seq.</i>
ft bls	Feet below land surface
GPCD	Gallons Per Capita Per Day
gpm	Gallons per minute
HSR	Hydrographic Survey Report
ID	Irrigation District
INA	Irrigation Non-expansion Area
LCR	Little Colorado River
LUST	Leaking Underground Storage Tank
maf	Million acre-feet
mg/l	Milligrams per liter
mgd	Million gallons per day
NDEQ	Navajo Department of Environmental Quality
NDWR	Navajo Department of Water Resources
NHA	Navajo Housing Authority
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service (U.S.)
NRA	National Recreation Area
NRCD	Natural Resources Conservation District
NRCS	Natural Resources Conservation Service
NTUA	Navajo Tribal Utility Authority
NWS	National Weather Service
Pan ET	Pan evaporation
P.L.	Public Law

RCD	Resource Conservation District
RVID	Round Valley Irrigation District
SLD	Arizona State Land Department
SNOTEL	SNOWpack TELemetry
SRP	Salt River Project
TDS	Total dissolved solids
TEPCO	Tucson Electric Power Company
TNC	The Nature Conservancy
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile organic compound
WIFA	Water Infrastructure Funding Authority
WQARF	Water Quality Assurance Revolving Fund
WRCC	Western Regional Climate Center
WWTP	Wastewater Treatment Plant

APPENDICES

APPENDIX A: Arizona Water Protection Fund Projects in the Eastern Plateau Planning Area Through 2005

Project Title/Grant #	Project Category
Lake Mary Watershed Streams Restoration/00-108	Channel Restoration
Little Colorado River Riparian Restoration Project/99-079	Constructed Wetland & Revegetation
Talastima (Blue Canyon) Watershed Restoration Project/97-037	Exotic Species Control & Fencing
Continued Enhancement of Pueblo Colorado Wash at Hubbell Trading Post National Historic Site/00-104	Exotic Species Control & Stream Restoration
Saffell Canyon and Murray Basin Watershed Restoration/96-0022	Feasibility Study
Town of Eagar/Round Valley Water Users Association Pressure Irrigation Feasibility Study & Preliminary Design/99-089	Feasibility Study
Town of Eagar/Round Valley Water Users Association Pressure Irrigation Feasibility Study and Preliminary Design – Additional Mapping for Water Quality Improvements in the Watershed/00-112	Feasibility Study
Completion Phase: Hi-Point Well Project/96-0002	Fencing
EC Bar Ranch Water Well Project/98-046	Fencing & Water Developments
Brown Creek Riparian Restoration/99-095	Fencing & Water Developments
Upper Fairchild Draw Riparian Restoration/00-110	Fencing & Revegetation
Polacca Wash Grazing Management/00-113	Fencing & Exotic Species Control w/ Revegetation
Wet Meadows for Water Quality and Wildlife – A Riparian Restoration Project/03-119	Fencing & Habitat Protection
EC Bar Ranch Wildlife Drinker Project/99-067	Livestock & Wildlife Water Developments
Evaluation of Carex Species for Use in Riparian Restoration/98-051	Research
Assessments of Riparian Zones in the Little Colorado River Watershed/99-084	Research

Project Title/Grant #	Project Category
Hubbell Trading Post Riparian Restoration with Treated Effluent/00-105	Revegetation
Wilkins' family Little Colorado River Riparian Enhancement Project/05-125	Stream Restoration
X Diamond Ranch LCR Riparian Enhancement Project/05-126	Stream Restoration
Hoxworth Springs Riparian Restoration Project/96-0003	Stream Restoration
Demonstration Enhancement of Pueblo Colorado Wash at Hubbell Trading Post/97-029	Stream Restoration & Revegetation
Little Colorado River Enhancement Demonstration Project/99-092	Stream Restoration
EC Bar Ranch Reach 8 Water Well and Drinker Project/05-127	Water Developments
Tsaile Creek Watershed Restoration Demonstration/96-0025	Watershed Restoration
Murray Basin and Saffell Canyon Watershed Restoration Project/00-101	Watershed Restoration

APPENDIX B: Watershed Partnerships in the Eastern Plateau Planning Area (2005)

MULTI-PLANNING AREA - Eastern Plateau, Western Plateau and Central Highlands

Watershed Partnership	Primary Participants		Projects & Accomplishments	Issues
Coconino Plateau Water Advisory Council	Flagstaff Williams Page	Coconino County Sedona Tusayan	<ul style="list-style-type: none"> 4 categories of potential water augmentation projects have been identified along with their associated costs. 	<ul style="list-style-type: none"> Excessive growth throughout entire plateau Limited and deep groundwater supplies. Drought sensitive surface water supplies of Williams, Flagstaff and others
	TNC Trust Doney Park Water Co.	Grand Canyon	<ul style="list-style-type: none"> Groundwater study and conceptual model completed Phase I Water Demand Study for Coconino Plateau 	<ul style="list-style-type: none"> Unsafe dam issues in Williams Groundwater salinity issues in northeastern part of plateau
	Navajo Nation Havasupai Tribe	Hopi Tribe Hualapai Tribe	<ul style="list-style-type: none"> Growth Impacts Study Western Navajo Pipeline Study Development of study for importing C aquifer groundwater east of Flagstaff has been completed. 	<ul style="list-style-type: none"> Numerous water haulers with few hauling stations that are sometimes cutoff during drought Unable to get adequate water supply designation under current definition
	ADWR State Land NAU	ADEQ NRCD	<ul style="list-style-type: none"> Flagstaff, Hopi and Navajo are exploring cooperative opportunities for developing C aquifer groundwater. 	<ul style="list-style-type: none"> Growth in Page with no means of additional supply ESA issues with groundwater usage and impacts on perennial streams
	USBoR USFS Grand Canyon Glen Canyon NRCS	USGS BLM National Park NRA	<ul style="list-style-type: none"> Flagstaff purchased Red Gap Ranch for possible future development of groundwater. Hopi HSR initiated. Conducting Water Appraisal Study to identify current & future demands and alternatives for meeting projected demands. Developing numeric model 	<ul style="list-style-type: none"> Potential limitation of groundwater usage from reserved groundwater rights of Indians Uncertainty of Indian water right settlements (LCR & Colorado River) Proposed San Juan Paiute reservation west of Flagstaff Potential impacts on springs in Grand Canyon and also on supplies to Havasupai and Hualapai reservations Access to water development on public lands Limited groundwater data for entire region Minor Arsenic issues in Woody Mtn. Well field (9-14 ppb) Unregulated lot splits Limited funding resources for planning, projects, infrastructure and studies Extremely high cost of water augmentation projects

MULTI-PLANNING AREA – Eastern Plateau, Western Plateau and Central Highlands (continued)

Watershed Partnership	Primary Participants		Projects & Accomplishments		Issues	
Northern Arizona Municipal Water Users Association (NAMWUA)	Prescott	Prescott Valley	?	Projected water demands through 2040 have been identified	?	Limited supplies to meet projected demands
	Flagstaff	Williams			?	ESA issues impacting potential ground and surface water supplies
	Cottonwood	Clarkdale	?	A request for 70,000 acre-feet of CAP reallocation water has been submitted to ADWR for consideration.	?	Limited funding resources for planning, projects, infrastructure and studies
	Sedona	Payson			?	Competition from Phoenix/Tucson for CAP reallocation water
	Chino Valley				?	Funding for Colorado River infrastructure
					?	Water quality issues in Verde Valley and Flagstaff
					?	Upper Basin/Lower Basin issues with Colorado River affect potential for use

EASTERN PLATEAU PLANNING AREA

Watershed Partnership	Primary Participants		Projects & Accomplishments		Issues	
Little Colorado Watershed Coordinating Council (Formerly Little Colorado River Multi-Objective Management Partnership (LCRMOM))	Winslow Navajo County	Holbrook	?	Development and Ecosystem Restoration Program study for the Montane Forest Regimes completed.	?	Potential impacts on groundwater system from power plants
	NRCD/RCD	NAU			?	Water quality issues involving arsenic and TDS
	USBor	COE	?	Watershed reconnaissance study	?	Unresolved adjudication and Indian water rights settlements
					?	Limited groundwater data for entire region
		?	Invasive species (Tamarisk)			
		?	ESA issues			
				?	Drought impacts on surface water supplies	
				?	Limited funding resources for planning, projects, infrastructure and studies	

EASTERN PLATEAU PLANNING AREA (continued)

Watershed Partnership	Primary Participants	Projects & Accomplishments	Issues
Navajo Nation	NDWR NTUA NDEQ NHA ADWR USBoR COE BIA HIS	? Survey of agricultural lands in Upper Basin ? Groundwater elevation survey of NTUA wells ? Water Quality ATLAS ? Navajo Drought Report ? Western Navajo Water Supply Study	? Lack of technical groundwater data ? Limited groundwater supplies to meet projected demands ? Water quality issues ? Prone to impacts from drought ? Unresolved water right claims to LCR and Colorado R. ? Upper Basin/Lower Basin issues with Colorado River ? Gallup to Window Rock Pipeline in jeopardy (financial, upper/lower basin issues, ESA and others)
Show Low Creek Watershed Partnership	Show Low Lakeside-Pinetop Navajo Cty Show Low Creek Irrigation District Local Citizenry ADWR AZ Game & Fish	? Groundwater elevations study ? GPS survey of agricultural lands ? Development of a water resources management plan initiated. ? Development of a water budget initiated.	? Drought impacts on surface water supplies and springs resulting in impacts on agriculture and cattle ranching ? Seasonal demands impacting peak demands ? Growth ? Unresolved adjudication and Indian water rights settlements ? Limited funding resources for planning, projects, infrastructure and studies
Silver Creek Watershed Partnership	Snowflake Taylor Holbrook Winslow Show Low Navajo County Silver Creek ID Show Low Creek Watershed Partnership ADWR NAU	? Silver Creek channel and riparian restoration study completed. ? Value Engineering Analysis of Unsafe Dams completed ? Silver Creek HSR ? Development of a water budget initiated.	? Limited groundwater data ? Potential impacts on groundwater system from Cholla Power plant ? Drought impacts on surface water supplies for agriculture ? Several high hazard unsafe dams ? Unresolved adjudication and Indian water rights settlements ? Perception of no real supply problem ? Water quality concerns in some areas (salinity) ? Limited funding resources for planning, projects, infrastructure and studies

EASTERN PLATEAU PLANNING AREA (continued)

Watershed Partnership	Primary Participants	Projects & Accomplishments	Issues
Upper Little Colorado River Watershed Partnership	Springerville Greer Apache County Eagar Nutrioso Round Valley Irrigation District Local Citizens and Special Interest Groups ADWR AZG&F ADEQ NRCS/RCD USBor USFS	? Aerial mapping survey and GIS coverage of the Little Colorado River (LCR) and its tributaries completed. ? Geomorphic and biological assessment of the LCR completed. ? Stream riparian restoration project ? Round Valley Irrigation Delivery System partially upgraded. ? Preliminary water budget completed ? Reconstruction of River Reservoir Dam completed. ? The interconnection of Springerville and Eagar's wastewater treatment facilities is being pursued.	? Limited groundwater data ? Potential impacts to the groundwater system from TEPCO generating station. ? Unresolved adjudication and Indian water rights settlements ? Proposed development in Greer and impacts on Little Colorado River ? Drought impacts on forage for grazing and surface water availability for agriculture ? Potential impacts on tourism due to drought ? Funding issues for water delivery infrastructure ? Political differences between Springerville and Eagar ? Perception of no real supply problem ? Limited funding resources for planning, projects, infrastructure and studies